

Ser no. 351229/38

TF 2000

A.F. Signal

Source

OPERATING INSTRUCTIONS

mi

MARCONI INSTRUMENTS

NOTES AND CAUTIONS

ELECTRICAL SAFETY PRECAUTIONS

This equipment is protected in accordance with IEC Safety Class 1. It has been designed and tested according to IEC Publication 348, 'Safety Requirements for Electronic Measuring Apparatus', and has been supplied in a safe condition. The following precautions must be observed by the user to ensure safe operation and to retain the equipment in a safe condition.

Defects and abnormal stresses

Whenever it is likely that protection has been impaired, for example as a result of damage caused by severe conditions of transport or storage, the equipment shall be made inoperative and be secured against any unintended operation.

Removal of covers

Removal of the covers is likely to expose live parts although reasonable precautions have been taken in the design of the equipment to shield such parts. The equipment shall be disconnected from the supply before carrying out any adjustment, replacement or maintenance and repair during which the equipment shall be opened. If any adjustment, maintenance or repair under voltage is inevitable it shall only be carried out by a skilled person who is aware of the hazard involved.

Note that capacitors inside the equipment may still be charged when the equipment has been disconnected from the supply. Before carrying out any work inside the equipment, capacitors connected to high voltage points should be discharged; to discharge mains filter capacitors, if fitted, short together the L (live) and N (neutral) pins of the mains plug.

Mains plug

The mains plug shall only be inserted in a socket outlet provided with a protective earth contact. The protective action shall not be negated by the use of an extension lead without protective conductor. Any interruption of the protective conductor inside or outside the equipment is likely to make the equipment dangerous.

Fuses

Note that the supply fuse is connected in series with the brown (live) wire of the supply lead. If the equipment is connected to the supply via a two-pin plug, it will be possible for the fuse to become connected to the neutral side depending upon the orientation of the plug in its socket. In these circumstances certain parts of the instrument could remain at supply potential even after the fuse has ruptured.

To provide protection against breakdown of the supply lead, its connectors, and filter where fitted, an external supply fuse (e.g. fitted in the connecting plug) should be used in the live lead. The fuse should have a continuous rating not exceeding 6 A.

Make sure that only fuses with the required rated current and of the specified type are used for replacement. The use of mended fuses and the short-circuiting of fuse holders shall be avoided.

OPERATING INSTRUCTIONS

No. EB 2000

for

A.F. Signal Source

TF 2000

(Supplement to EB 2100 & 2160)

RADIO FREQUENCY INTERFERENCE

This equipment conforms with the requirements of EEC Directive 76/889 as to limits of r.f. interference.

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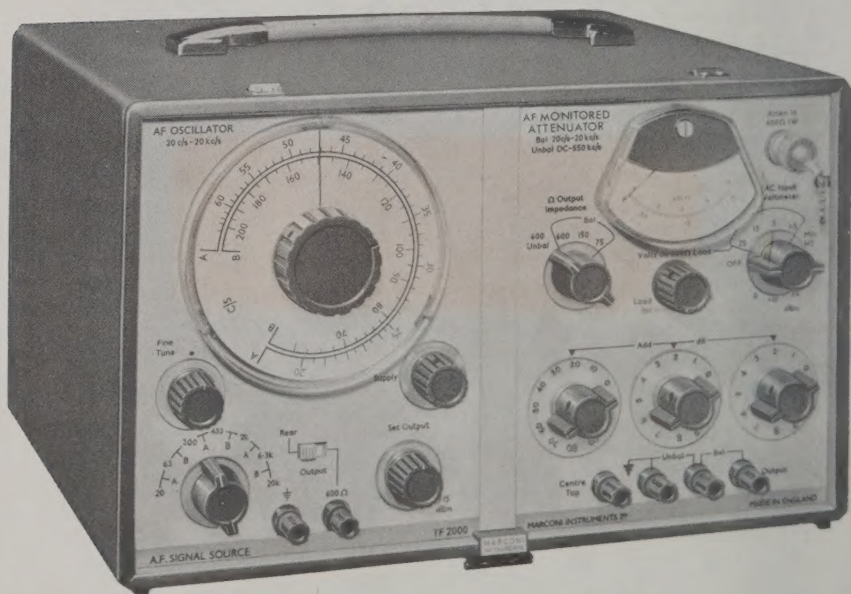
MARCONI INSTRUMENTS LIMITED
ST. ALBANS HERTFORDSHIRE ENGLAND

GENERAL INFORMATION

A. F. Signal Source TF 2000 comprises A. F. Oscillator TF 2100 and A. F. Monitored Attenuator TF 2160 assembled in a single case.

The Attenuator unit is not fitted with batteries, as it is when supplied on its own, but derives its power supply from the Oscillator unit via an internal rear link. Another link connects the rear outlet of the Oscillator to the rear inlet of the Attenuator. In other respects the two units can be used independently as described in the handbooks that accompany this supplement.

Performance figures for the composite instrument are given under Data Summary.



TF 2000. This view does not show the fine output control, now fitted, and shown in fig. 1.1 of the handbook for TF 2100.

Frequency

Range : 20 c/s to 20 kc/s in six bands. Auxiliary fine control.

Accuracy : $\pm 1\%$ ± 0.2 c/s.

Oscillator Power : +15 dBm (31.6 mW) to attenuator; over 8.5 V open circuit (600 Ω source impedance). At least 40 dB level control.

For other Oscillator performance details see Handbook for TF 2100.

Attenuator

Range : 0 to 111 dB in 0.1 dB steps. Residual loss : less than 0.01 dB at d.c. with unbalanced output.

Accuracy : $\pm 1\%$ of dB setting ± 0.2 dB.

Output Impedance : Unbalanced : 600 Ω .
Balanced : 600, 150 and 75 Ω .

Input Voltmeter : Ranges: 1.5, 5, 15 and 25 V full-scale; also marked -6 to +30 dBm. Accuracy $\pm 5\%$ of full-scale.

Frequency Response : Over the frequency range the output is level within ± 0.2 dB, at any attenuator setting, with the indication of the attenuator input meter held constant.

Distortion (with matched load) : Unbalanced output :
Less than 0.05% from 63 c/s to 6.3 kc/s;
less than 0.1% from 20 c/s to 63 c/s and
6.3 kc/s to 20 kc/s.

Balanced output :
Less than 0.1% from 50 c/s to 20 kc/s;
less than 0.3% from 30 c/s to 50 c/s.

Hum : Less than 0.01% (-80 dB) of output signal, or -90 dBm, whichever is the greater.

External Signal Through Attenuator

Input Level : Up to 25 V (1 W) into front panel or rear inlet, 600 Ω unbalanced.

Frequency Range : D.C. to 550 kc/s with unbalanced output. 20 c/s to 20 kc/s with balanced output.

For other Attenuator performance details see Handbook for TF 2160.

Power Supply : 190 to 260 V and 95 to 130 V, 45 to 500 c/s, 7 W.
Also 210 to 260 V and 105 to 130 V, 500 to 1000 c/s, 7 W.
Or, after resetting rear panel switch, 65 to 90 V d.c. floating, 60 mA.

Dimensions & Weight :	Height	Width	Depth	Weight
	7 3/4 in	11 1/2 in	10 1/2 in	20 lb
	(19.5 cm)	(29 cm)	(27 cm)	(9 kg)

Accessories Supplied :

- (1) One coaxial free plug, Type BNC.
- (2) One shielded adaptor, providing BNC outlet from terminals, Type GE51002.

OPERATING INSTRUCTIONS
No. EB 2100

for

A.F. Oscillator
TF 2100

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EB 2100
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I GENERAL INFORMATION

1.1 INTRODUCTION

A.F. Oscillator Type TF 2100 is a low distortion RC oscillator for audio frequency measurements in the range 20 c/s to 20 kc/s. This frequency range is covered in six bands, and there is an uncalibrated fine frequency control. The instrument will provide +15 dBm (31.6 mW) to a 600 Ω unbalanced load, and up to 8.5 V or more when the load impedance is high. The output is available at front panel terminals and is fed to these via a continuously variable 600 Ω attenuator having an uncalibrated range of more than 40 dB. Compactness has resulted from the use of transistors throughout. The power supply circuit permits operation from either a.c. mains or a d.c. source.

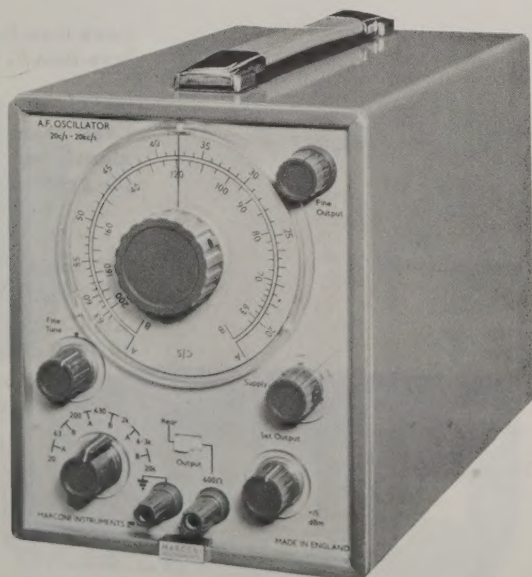


Fig. 1.1
A.F. Oscillator
Type TF 2100

1.2 DATA SUMMARY

Frequency

Range : 20 c/s to 20 kc/s, in six bands. Auxiliary fine control.

Accuracy : $\pm 1\% \pm 0.2$ c/s.

Output

Power : +15 dBm (31.6 mW) into 600 Ω ; over 8.5 V open circuit.

Control : At least 40 dB range of attenuation, by continuously variable T-network.

Impedance : 600 $\Omega \pm 20\%$ unbalanced.

Frequency Response :

Over the frequency range, the change in output level is less than ± 0.4 dB.

Distortion :

Less than 0.05% from 63 c/s to 6.3 kc/s; less than 0.1% from 20 c/s to 20 kc/s.

Hum :

Less than 0.01% (-80 dB) of output signal, or -100 dBm, whichever is the greater.

Power Supply :

190 to 260 V and 95 to 130 V, 45 to 500 c/s, 7 W.

Also 210 to 260 V and 105 to 130 V, 500 to 1000 c/s, 7 W.

Or, after resetting rear panel switch, 65 to 90 V d.c. floating, 60 mA.

Dimensions :

Height	Width	Depth
7 3/4 in (19.5 cm)	5 3/4 in (14.5 cm)	10 1/2 in (27 cm)

Weight :

8 1/2 lb (3.75 kg)

Accessories Supplied

One coaxial free plug, Belling Lee List No. L1465/FP/Ag.

Accessories Available

- (a) Modular rack mounting case Type TM 7010.
- (b) Blank Panel Unit Type TM 6844.
- (c) Shielded adaptor Type TB 39868 (Greenpar Type GE51002).

1.3 ASSOCIATED EQUIPMENT AND ACCESSORIES AVAILABLE

The A.F. Oscillator TF 2100 belongs to a series of instruments designed in the same size or multiples of this size (the width varying). To enable these units to be mounted together in a standard 19 inch rack, case Type TM 7010 is available. The TF 2100 and two other units of the same size (or one other unit twice the width of the TF 2100) can be fitted in line in this case, which has slotted brackets at each end for rack fixing. Unoccupied spaces in the case can be filled by one or more Blank Panel Units Type TM 6844, each being 1/3 of the width of the case.



Fig. 1.3
Rack mounting case
Type TM 7010
with one compartment
occupied

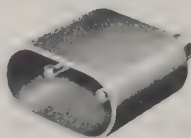


2100 (1)

Fig. 1.2
Blank Panel Unit
Type TM 6844

Three instruments that may singly be used with the TF 2100, and which belong to the same series, are A.F. Monitored Attenuator TF 2160, M.F. Attenuator TF 2162, and M.F. Monitored Attenuator TF 2161. Each has the same dimensions as the TF 2100, and can be mounted in another compartment beside the TF 2100 in a TM 7010 case. When one of the Attenuators and the TF 2100 are together in the case, it is easy to link the two between their rear panels; in these circumstances, in addition to the signal, the TF 2100 can supply the d.c. requirements of a TF 2160 or TF 2161, which otherwise use batteries.

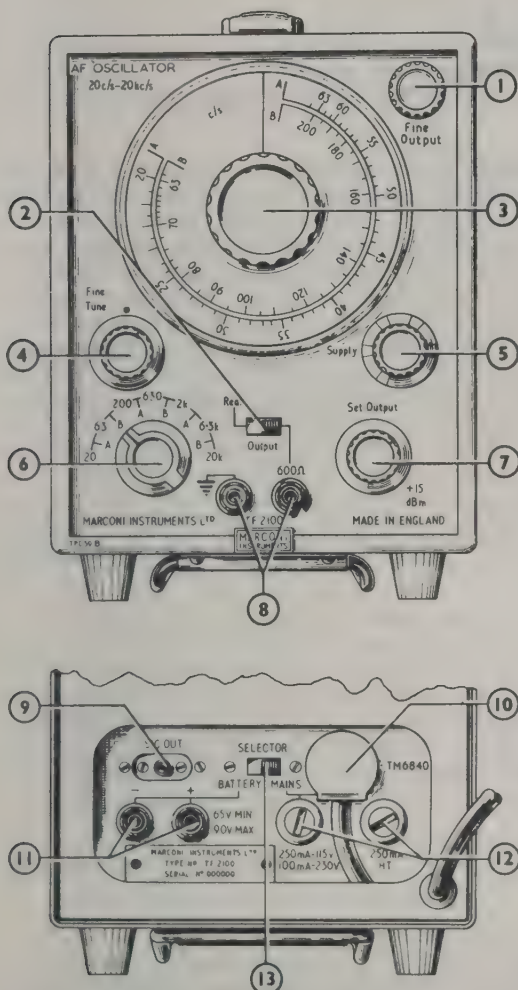
Fig. 1.4 Shielded
Adaptor Type TB 39868



Also available is a shielded adaptor, Type TB 39868 (Greenpar Type GE51002), which can be plugged onto the output terminals of an A.F. Oscillator to convert them into effectively a BNC coaxial socket outlet.

2 OPERATION

2.1 CONTROLS AND CONNECTORS



Not shown :

Concealed by the rear cover is a twin socket, H.T. OUT, which can be used to feed a TF 2160 A.F. Monitored Attenuator.

Fig. 2.1

Controls and Connectors

2.2 PREPARING FOR USE

POWER SUPPLY

The A.F. Oscillator can be operated from an a.c. or a d.c. source, according to the setting of the SELECTOR switch at the rear. Press this to the right if an a.c. source will be used, or to the left if the source will be d.c.

Normally the instrument is despatched ready for operation from an a.c. source having a voltage (including possible variation above or below nominal value) in the range 190 to 260 V. For an a.c. voltage within the limits 95 to 130 V, the tags on the mains transformer must be linked differently and the input fuse changed. The transformer connections and the fuses required are described in Sections 4.4 and 4.2. When the source is a.c., be sure that the instrument is ready accordingly for the voltage, then connect the mains lead to the supply point. At the end of the mains lead, the conductor carrying the yellow sleeve with the green symbol must only be connected to 'earth' ('ground'). It is advisable, but not essential, to make this connection. The black conductor, marked N, should preferably be connected to the neutral side of the supply, and the third conductor to the 'line' or 'phase' side.

A d.c. source can be between 65 and 90 V. It must be floating. Dry batteries can be used, but it should be noted that the drain is about 60 mA. Connect leads from the source to the appropriate terminals, marked + and -, at the rear.

PRECAUTIONS AGAINST HEAT

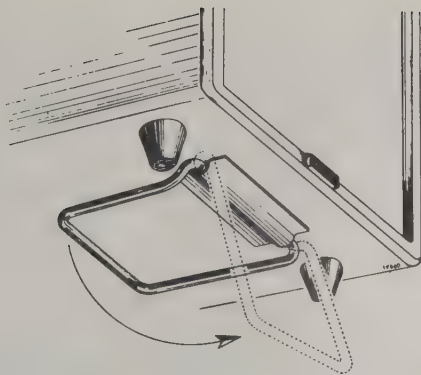
Employing transistors (some germanium), the instrument is accordingly susceptible to abnormal heat. Completely remove the plastic cover, if one is supplied over the case. Although the instrument is small and can be positioned easily, do not place it on top of, or close to, other equipment that may overheat it.

OPERATING POSITION

Underneath the case, near the front, is a folding stand. This can be pulled down and forward so that it will support the instrument in a tilted position on a bench; see Fig. 2.2. Having the front panel facing upwards in this manner can make operation easier in some circumstances.

For details regarding fitting the instrument with others in a rack mounting case TM 7010, see Section 2.5.

Fig. 2.2
Lowering Stand



SWITCHING ON

CAUTION - Be sure that the instrument is set correctly for the supply source.

Switch on by turning the **SUPPLY** switch clockwise. The instrument is ready for use almost immediately; the time taken to reach a high degree of stability depends on the setting of the frequency band switch, but is normally less than $\frac{1}{2}$ minute.

If a load is already connected, and is sensitive, it may be advisable to turn the **SET OUTPUT** control counter-clockwise before switching on. Initially, the generated signal may rise to approximately 50% above normal amplitude before stabilization takes place. Also - when the load impedance is high and the **SET OUTPUT** control is fully clockwise - a d.c. pulse of several volts appears briefly when the instrument is switched on and switched off, the pulse being positive and negative respectively.

2.3 SETTING FREQUENCY

To set the A. F. Oscillator to a particular frequency :-

- (1) Set the frequency band switch to a range that embraces the required frequency. On the front panel, each position of the frequency band switch falls between two figures, which indicate in c/s the frequency limits of the band obtained at that position. Each position is also marked with a letter, A or B, indicating whether scale A or B must be read on the frequency dial.

- (2) Turn the frequency control so that the dial indicates the required frequency, reading scale A or B depending on the setting of the frequency band switch; it will be found that the figures on this scale are either direct-reading or need only be multiplied by 10 or 100, according to the band selected.
- (3) Set the FINE TUNE control to the mark on the panel (i.e. the centre of its range of adjustment).

Example : To obtain a frequency of 4 kc/s.

Set the frequency band switch to the position between 2 k and 6.3 k. This position is marked A. Turn the frequency dial so that it reads 40 on scale A. Set the FINE TUNE control to its reference mark. See Fig. 2.3.

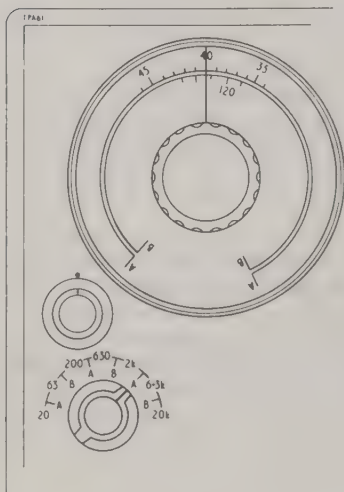


Fig. 2.3

**Frequency controls
set for 4 kc/s**

Because of the use of transistors, the tuning elements in the Oscillator are variable resistors. These are ganged and are of a wire-wound type, giving the greatest accuracy of calibration. But it should be noted that, as a result of the moving contacts passing over the discrete turns of wire in these components, some fluctuation of output may be experienced during tuning. Stabilization at the original output level takes place after any adjustment.

The FINE TUNE controls allows gradual and precise frequency adjustment over a limited range in the region of the setting of the main frequency control. It can be used to minimize the frequency calibration error of the main dial at a particular frequency and in its vicinity; by adjusting the FINE TUNE control, the reading of the main dial can be standardized against the indication of a counter connected to the output. The FINE TUNE control also facilitates setting the instrument exactly to the optimum pass or rejection frequency of a highly selective circuit, such as a filter having a narrow frequency response.

2.4 OUTPUT

Before connecting a sensitive load to the instrument, turn the SET OUTPUT control fully counter-clockwise to avoid applying too much output.

Output from the A.F. Oscillator can be taken from the front panel terminals, or from the Belling Lee miniature coaxial socket, SIG OUT, at the rear, depending on the setting of the switch above the terminals on the front panel. Set this to the right for front terminals output, or to the left for use of the rear coaxial socket. The front terminals contain sockets for 4 mm plugs and will accept a twin plug having 3/4 inch spacing.

CAUTION: The 'live' front panel terminals, or the centre socket of the rear coaxial outlet, is fed internally through a reversible electrolytic capacitor. Damage may result if the load applies more than ± 25 V d.c. back to the instrument.

From the fully counter-clockwise position, turn the SET OUTPUT control clockwise, raising the output, until the required level is obtained. When the control has been rotated through a small angle from the extreme counter-clockwise position, it enters upon an approximately linear range of at least 40 dB adjustment. Maximum output, when the control is fully clockwise, is at least +15 dBm into a 600 Ω load, or up to more than 8.5 V across a high impedance load. Make small adjustments to the level with the FINE OUTPUT control. This control has a range of approximately 0.7 dB.

The source impedance is 600 Ω , unbalanced, at either the front panel terminals or the rear coaxial outlet. The accuracy of this value of impedance is particularly good at maximum output, when the SET OUTPUT control is fully clockwise.

To obtain good shielding and facilitate employing coaxial cable leads, the use of an adaptor TB 39868 (an optional accessory) is recommended. This, in effect, converts the output terminals into a BNC socket.

2.5 MOUNTING IN CASE TM 7010

FITTING PROCEDURE

To fit an A.F. Oscillator in a rack-mounting case Type TM 7010, proceed as follows :-

- (1) Remove the instrument from its case; see Section 4.3.
- (2) Fit the rear cover of the rack-mounting case into the channels provided at the rear edge of the case. The large aperture should be lower than the ventilating slots. (The bottom of the case is the separate panel assembled to the rest).
- (3) Select the compartment to be occupied by the A.F. Oscillator (removable divisions separate the case into three sections) and slide the unit in backwards, keeping the rear end up to avoid the screws in the bottom of the case.
- (4) Insert the two coin-slotted screws, originally in the case of the A.F. Oscillator, through the appropriate holes in the rear cover of the rack-mounting case, and tighten them to the bar at the rear of the A.F. Oscillator.

To free the mains lead held in the rear cover taken off the A.F. Oscillator, press down with pliers the smaller of the two plastic pieces making up the bush through the cover, and push the bush assembly and lead through the hole. Alternatively, the socket can be removed from the mains lead and used in making up a suitable lead for the instrument when mounting in a rack.

LINKING TO AN ATTENUATOR

The subsidiary coaxial outlet at the rear of the A.F. Oscillator can conveniently be linked to the coaxial inlet at the rear of a A.F. Monitored Attenuator TF 2160, a M.F. Monitored Attenuator TF 2161, or a M.F. Attenuator TF 2162. The Belling Lee miniature coaxial sockets are accessible through the aperture in the rear cover of the case TM 7010. A coaxial lead for this purpose is available as an optional accessory with the Attenuators.

It is also possible to provide the d.c. requirements to the monitor circuit in the TF 2160 or TF 2161 from the TF 2100 when either Attenuator and the Oscillator are together in a case TM 7010. To do this, insert both

units in the case, the Attenuator on the right-hand side of the Oscillator, with the rear cover of the case off. Remove the batteries from the rear of the Attenuator. Remove the battery supply plug from the twin socket on the rear of the Attenuator and link this socket instead with the HT OUT socket on the rear of the A.F. Oscillator; a lead for this purpose is also available as an optional accessory with the Attenuators TF 2160 and TF 2161. Fit the rear cover of the case and secure the units as described above.

3 CIRCUIT SUMMARY

Basically, the A.F. Oscillator consists of a multistage transistor amplifier, two overall feedback loops creating and stabilizing oscillation, and an attenuator controlling the output. The circuit arrangement is shown in the block diagram, Fig. 3.1. The instrument also contains power supply circuits.

3.1 AMPLIFIER AND OUTPUT CONTROL

The first stage of the amplifier employs transistor VT5 in a common-collector or emitter-follower circuit. This is a current amplifier taking as input the net signal derived from the two feedback paths. The transistor used here is a silicon n-p-n type, as are all the others in the amplifier.

The voltage gain in the system is provided by the second stage, VT6. In this, a common-emitter circuit produces high gain as a result of a high effective a.c. collector load impedance obtained by a bootstrap arrangement; the collector load resistor is not fed directly from the d.c. supply but via the emitter of an auxiliary transistor, VT7, driven from a further point in the amplifier chain.

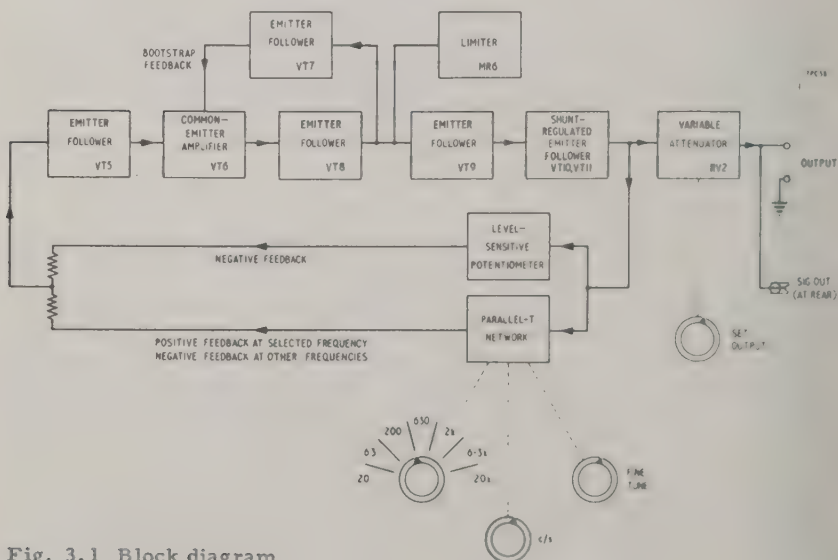


Fig. 3.1 Block diagram

Two successive emitter-followers, VT8 and VT9, amplify the signal current. At the output of the first, the auxiliary transistor VT7 receives its drive; and also at this point diode limiter MR6 is connected, to control the amplitude of initial oscillations at switch-on. The second emitter-follower, VT9, drives the output stage.

In the final stage, a low source impedance and low distortion output are provided by a shunt-regulated emitter-follower, VT10 and VT11. The two paths of a.c. feedback derive their signals from the output of this stage. Beyond, the low output impedance is padded up by resistance to present a constant and suitable value of source for the output level control circuit. The output stage has its working conditions stabilized by d.c. negative feedback, returned from it to the first transistor of the amplifier, all the transistors being d.c. coupled.

The output level of the A.F. Oscillator is determined primarily by a $600\ \Omega$ T-network attenuator; fine control is achieved by a small variable resistor in series with the attenuator. Both controls are continuously variable and un-calibrated. The attenuator is connected to either the front panel terminals or the rear coaxial socket according to the setting of S3. The rear outlet is intended to facilitate linking to associated equipment, particularly Monitored A.F. Attenuator Type TF 2160.

3.2 FEEDBACK

Two a.c. feedback paths exist between the output of the final stage and the input of the first stage of the amplifier.

One of these determines the frequency of oscillation by providing positive feedback at a chosen frequency through a variable parallel-T network. This network has continuously variable resistors RV6a to RV6c which are ganged together and form a tuning control over a frequency band, and switched capacitors, C17 to C29, enabling a series of six bands to be covered. At frequencies above and below the chosen frequency phase changes in the network cause the feedback to be negative; this provides a considerable measure of harmonic distortion suppression.

The other a.c. feedback path conveys negative feedback at all frequencies. At the selected frequency of oscillation it is overcome by the positive feedback at the junction where the two feedback paths enter the amplifier. This wide-band negative feedback is derived from two successive resistive potentiometers at the output of the amplifier. In the first potentiometer, thermistor TH1 occupying the upper arm is sensitive to the level of output and varies its resistance, and therefore varies the negative feedback, so that the level of output is stabilized, and also so that the strength of oscillation is always moderate (and therefore generates a minimum of distortion). In the second potentiometer, a physically larger thermistor, TH2, in the lower arm is primarily sensitive to ambient temperature and compensates for the effect of this on the first thermistor.

3.3 POWER SUPPLY CIRCUITS

The A.F. Oscillator has a mains transformer and a full-wave rectifier circuit, feeding the instrument through a series regulating circuit employing p-n-p transistors, VT1 to VT4.

On the mains transformer, T1, are two primary windings, which can be linked in series or parallel to permit operation from a.c. supplies giving between 190 and 260 V or between 95 and 130 V respectively.

Terminals and switch S2 at the rear allow the input of the regulating circuit to be fed from an external d.c. source. A series semiconductor diode, MR1, protects the instrument against the application of the wrong polarity.

4 MAINTENANCE NOTES

4.1 GENERAL

This part of the handbook is intended to provide guidance where it is most likely to be needed in servicing the instrument. In cases of difficulty that cannot be resolved with the aid of this book, or for general advice on maintaining the instrument, please write or phone our Service Division, or nearest Area Office or Agent. (Always mention the type number and serial number of your instrument. For addresses, see rear cover.)

4.2 FUSES

The circuits of the A.F. Oscillator are protected by two fuses : FS1, in series with one supply input connection to the mains transformer; and FS2, in series with the centre tap of the secondary of the mains transformer or in series with the positive input from a battery, depending on the setting of the supply SELECTOR switch, S2.

The fuse holders are accessible at the rear of the A.F. Oscillator. The holder for FS1 is marked 250 mA - 115 V and 100 mA - 230 V; the marked voltages are representative of the overall ranges 90 to 130 V and 190 to 260 V, for which 250 mA and 100 mA fuses should be fitted respectively. The holder of FS2 is marked 250 mA HT.

Replacement fuse links should be 20 x 5 mm cartridges of the quick acting, low breaking capacity type (in accordance with Sheet II of International Electrotechnical Commission Publication 127).

4.3 ACCESS TO COMPONENTS

REMOVING CASE

To remove the case of the A.F. Oscillator :

- (1) Withdraw the two coin-slotted screws from the rear of the A.F. Oscillator. Disconnect the mains lead socket from the rear inner panel. Remove the rear cover with the mains lead captive, if the rear cover is loose.
- (2) Slide the A.F. Oscillator chassis forward from the case. Alternatively, the front panel can be rested face downwards on a soft surface and the case lifted off.

OPENING CHASSIS

The chassis of the A.F. Oscillator consists of the front panel and three other sections hinged to it. The four sections are normally arranged in the form of a rectangle when viewed from above, and are held in this position by screws. The four sections can be hinged open as follows (see Fig. 4.1) :

- (1) Underneath, near the rear, slacken the two 6 BA screws in slots, one at each side of the web that spans the chassis.
- (2) Slacken the two relatively large screws at the left-hand side of the rear section until the shoulders under the heads of the screws are clear of the slots through which the screws pass. It should then be possible to separate the chassis at this corner, so that the sections can be hinged open.

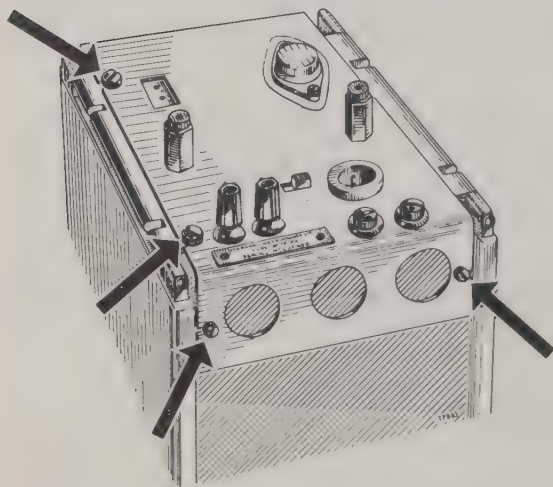


Fig. 4.1

To open chassis,
slacken these screws

PRINTED WIRING BOARDS

A printed board is framed in each of the two longer sections of the chassis. The wiring sides are facing outwards.

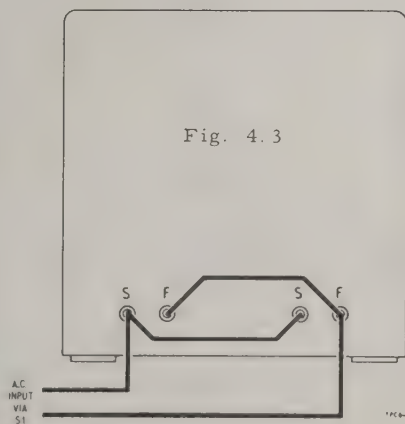
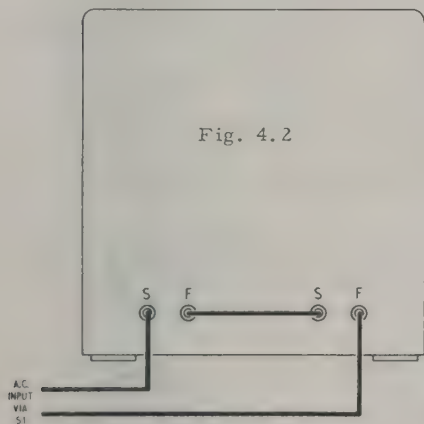
Each board is held in its frame by plastic clips. Press these to release the board, having disconnected such leads as necessary.

4.4 MAINS TRANSFORMER CONNECTIONS

To examine the connections to the two primaries of the mains transformer, remove the case. To make adjustments to the soldered connections, it is also necessary to hinge open the chassis, see Section 4.3.

If the a.c. supply voltage will lie between 190 V and 260 V, the two primaries must be in series and have a link between the finish F of one and the start S of the other. The a.c. input must be applied to the other F and S terminals. These connections are shown in Fig. 4.2.

If the a.c. supply voltage will lie between 95 V and 130 V, the two primaries must be in parallel and have a link between the two terminals marked S and a second link between the two terminals marked F. The a.c. input must be applied to one S terminal and one F terminal. These connections are shown in Fig. 4.3.



Transformer primary connections for

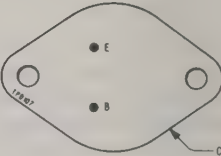
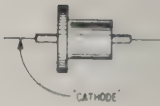
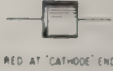
190 - 260 V

95 - 130 V

4.5 SEMICONDUCTORS

Table 4.1 shows the circuit reference numbers, type numbers, and connection diagrams of the transistors and semiconductor diodes used in the instrument. Some alternative types are also given, particularly those which may be fitted when the instrument is supplied.

TABLE 4.1

Circuit Ref. No.	Type	Alternatives	Connection Diagram
VT1 VT2 VT3	ACY17		
VT4	2N1531	OC 36 NKT403 2N458	
VT5	2S703		
VT6 VT7 VT8	2S104		
VT9	2S103		
VT10 VT11	2N696		
MR1 MR7	1N540	VA724 SJ402F DD226 40AS 1S103	
MR2 MR3	DD058		
MR4 MR5	ZOB18		
MR6 MR8	OA95	1N63 HG1005 1G26	

4.6 WORKING VOLTAGES

The voltage given in Tables 4.2 and 4.3 are representative of those to be expected on an a.c. operated A.F. Oscillator if measurements are made with a multi-range meter having a sensitivity of 20 k Ω per volt (e.g., an Avometer 8), using the lowest range suitable for each reading. When checking these voltages, allowance should be made for permissible variations in semiconductor performance and component values which may be found on an individual instrument.

It is assumed that the stabilized d.c. supply voltage is correctly set at 55 V; see Section 4.7.

TABLE 4.2.

Power supply circuit voltage relative to
positive d.c. supply line (tag 12 on amplifier board)

Transistor	Emitter	Base	Collector	See Note
VT1	-36	-36	-56	
VT2	-56	-56	-87	A
VT3	-56	-56	-87	A
VT4	-56	-56	-87	A

At each tag '3' on transformer T1 : 80 V a.c. See note A.

NOTE A : the voltages at the collectors of VT2, VT3, and VT4, and on T1, are dependent on the a.c. supply voltage. The values given are those to be expected if the value of the supply voltage is the mean of the range for which the instrument is set.

TABLE 4.3.

Amplifier transistor voltages relative to negative d.c.
regulated supply line (tag 9 on amplifier board)

Transistor	Emitter	Base	Collector	See Note
VT5	2	2.6	17	
VT6	2	2.2	29	
VT7	33.5	35	55	
VT8	28.8	29.2	55	
VT9	28	28.6	55	
VT10	27.5	28	53.2	B
VT11	1.9	2.4	26.7	

NOTE B : Emitter voltage of VT10 is set by RV4; see Section 3.7.

4.7 PRESETS

Although small adjustments can be made to any of the presets RV1 and RV3 - RV5 alone, it is preferable to check and, if necessary, adjust them all in the following order, RV1, RV4, RV3 and RV5.

RESISTOR RV1

This control determines the voltage of the stabilized d.c. supply feeding the amplifier. The potential should be +55 V at tag 12, relative to tag 9, on the component side of the right-hand printed board.

It is probable that readjustment will be necessary if any of the transistors VT1 to VT4 are changed.

RESISTOR RV3

This sets the gain of the amplifier. The gain should be 400 between test points TP1 and TP2, on the right-hand printed board, measured as follows :-

- (1) Disconnect the positive feedback at tag 11 on the component side of the board.
- (2) Apply 25 mV at 1 kc/s from a $600\ \Omega$ source to TP1 on the wiring side of the board, using tag 21 on the component side as earth.
- (3) Read the output on a valve voltmeter connected to TP2 on the wiring side of the board, using tag 21 as earth. Adjust RV3, if necessary, to obtain 6 V r.m.s.

RV3 may require readjustment if any of the transistors VT5 to VT11 are changed, particularly VT6.

RESISTOR RV4

Distortion in the output can be minimized by means of this control. It also varies the positive d.c. voltage at test point TP2 on the wiring side of the right-hand printed board, relative to tag 9 on the component side. This voltage must lie in the range 26 V to 29 V when RV4 is set.

Changing any of the transistors VT5 to VT11 may make readjustment of RV4 necessary.

RESISTOR RV5

Variable resistor RV5, forming part of the level-sensitive potentiometer network, is a means of setting the negative feedback providing level stabilization. To do this :

- (1) Set the instrument so that it is oscillating normally at 1 kc/s.
- (2) Check the voltage at test point TP2 on the wiring side of the right-hand printed board, relative to tag 21 on the component side, using a valve voltmeter. It should be 11 V r.m.s. Adjust RV5 if necessary. RV5 may need readjustment if thermistor TH1 or TH2 is changed.

RESISTORS RV8-RV19

These set the limits of the frequency bands. Normally, they should not be moved.

COMPONENTS

Component Ref.	Description	Works Ref.
CAPACITORS		
C1	.001 μF $\pm 20\%$, 300 V a.c.	55-TM6840
C2	100 μF +50 -20%, 150 V	20-TM6873
C3	.1 μF $\pm 20\%$, 150 V	21-TM6873
C4	5 μF +100 -20%, 70 V	22-TM6873
C5	100 μF +50 -20%, 100 V	20-TM6873
C6	5 μF +100 -20%, 50 V	28-TM6879
C7	.01 μF $\pm 20\%$, 400 V	36-TM6879
C8	50 μF +100 -20%, 12 V	30-TM6879
C9	25 μF +100 -20%, 25 V	31-TM6879
C10	5 μF +100 -20%, 50 V	28-TM6879
C11	10 pF ± 0.5 pF, 750 V	29-TM6879
C12	100 μF +50 -20%, 100 V	32-TM6879
C13	220 pF $\pm 20\%$, 600 V	57-TM6840
C14	100 μF +100 -20%, 50 V	34-TM 6879
C15	1000 μF +50 -20%, 6 V	33-TM6879
C16	100 μF +100 -20%, 25 V Reversal	56-TM6840
C17A	1.771 μF total $\pm 1\%$, 50 V (Matched Set)	7-TM6880
C17B		7-TM6880
C17C		7-TM6880
C17D		7-TM6880
C18	.56 μF $\pm 1\%$, 50 V	10-TM6880
C19	.1771 μF $\pm 1\%$, 50 V	11-TM6880
C20	.056 μF $\pm 1\%$, 50 V	12-TM6880
C21	.01771 μF $\pm 1\%$, 50 V	13-TM7057
C22	5600 pF $\pm 1\%$, 50 V	14-TM7057
C23	1750 pF $\pm 1\%$, 125 V	15-TM7057
C24	1750 pF $\pm 1\%$, 125 V	15-TM7057

Component Ref.	Description	Works Ref.
CAPACITORS (continued)		
C25	5600 pF $\pm 1\%$, 50 V	14-TM7057
C26	.01771 μ F $\pm 1\%$, 50 V	13-TM7057
C27	.056 μ F $\pm 1\%$, 50 V	12-TM6880
C28	.1771 μ F $\pm 1\%$, 50 V	11-TM6880
C29	.56 μ F $\pm 1\%$, 50 V	10-TM6880
FUSES		
FS1	100 mA or 250 mA	71-TM6840
FS2	250 mA	72-TM6840
SEMICONDUCTOR DIODES		
MR1	1N540	61-TM6840
MR2	DDO 58	27-TM6873
MR3	DDO 58	27-TM6873
MR4	ZOB18	28372-587
MR5	ZOB18	28372-587
MR6	OA95	28323-287
MR7	1N540	47-TM6879
MR8	OA95	28323-287
PLUGS		
PL1	MAINS, 3-pin	67-TM6840

Component Ref.	Description	Works Ref.
RESISTORS		
R1	33 k Ω $\pm 10\%$, 1/2 W	2-TM6873
R2	820 k Ω $\pm 10\%$, 1/2 W	3-TM6873
R3	470 Ω $\pm 10\%$, 1/2 W	4-TM6873
R4	10 Ω $\pm 10\%$, 1/2 W	5-TM6873
R5	22 k Ω $\pm 10\%$, 1/2 W	6-TM6873
R6	10 Ω $\pm 10\%$, 1/2 W	5-TM6873
R7	4.7 k Ω $\pm 10\%$, 1/2 W	7-TM6873
R8	22 Ω $\pm 10\%$, 1/2 W	8-TM 6873
R9	10 k Ω $\pm 10\%$, 1/2 W	9-TM6873
R10	3.3 k Ω $\pm 10\%$, 1/2 W	10-TM6873
R11	11.75 k Ω $\pm 1\%$, 1/4 W	11-TM6873
R12	4 k Ω $\pm 1\%$, 1/4 W	12-TM6873
R13	100 Ω $\pm 10\%$, 1/2 W	14-TM6879
R14	6.8 k Ω $\pm 7\%$ TE, 3/8 W	15-TM6879
R15	33 k Ω $\pm 7\%$ TE, 3/8 W	16-TM6879
R16	10 k Ω $\pm 7\%$ TE, 3/8 W	47-TM6840
R17	22 k Ω $\pm 10\%$, 1/2 W	4-TM6879
R18	2.2 k Ω $\pm 10\%$, 1/2 W	23-TM6879
R19	10 k Ω $\pm 10\%$, 1/2 W	6-TM6879
R20	3.3 k Ω $\pm 10\%$, 1/2 W	7-TM6879
R21	100 k Ω $\pm 10\%$, 1/2 W	8-TM6879
R22	47 k Ω $\pm 10\%$, 1/2 W	3-TM6879
R23	6.8 k Ω $\pm 10\%$, 1/2 W	9-TM6879
R24	100 Ω $\pm 10\%$, 1/2 W	14-TM6879
R25	1 k Ω $\pm 10\%$, 1/2 W	5-TM6879

TE = Total Excursion.

Component Ref.	Description	Works Ref.
RESISTORS (continued)		
R26	33 k Ω $\pm 7\%$ TE, 3/8 W	16-TM6879
R27	4.7 k Ω $\pm 7\%$ TE, 3/8 W	11-TM6879
R28	100 Ω $\pm 10\%$, 1/2 W	14-TM6879
R29	22 k Ω $\pm 10\%$, 1/2 W	4-TM6879
R30	82 Ω $\pm 7\%$ TE, 3/8 W	22-TM6879
R31	47 Ω $\pm 10\%$, 1/2 W	12-TM6879
R32	13 k Ω $\pm 7\%$ TE, 3/8 W/55 $^{\circ}$ C	18-TM6879
R33	1 k Ω $\pm 7\%$ TE, 3/8 W	19-TM6879
R34	15 k Ω $\pm 7\%$ TE, 3/8 W	20-TM6879
R35	1 k Ω $\pm 10\%$, 1/2 W	5-TM6879
R36	5.6 k Ω $\pm 10\%$, 1/2 W	13-TM6879
R37	1 k Ω $\pm 10\%$, 1/2 W	5-TM6879
R38	549 Ω $\pm 1\%$, 1/4 W	24636-811
R39	100 k Ω $\pm 10\%$, 1/2 W	48-TM6840
R41	3860 Ω $\pm 1/2\%$, 1/4 W	7-TM7057
R42	3860 Ω $\pm 1/2\%$, 1/4 W	7-TM 7057
R43	1675 Ω $\pm 1/2\%$, 1/4 W	8-TM7057
R44	33 k Ω $\pm 7\%$ TE, 3/8 W	6-TM7057
R45	1 k Ω $\pm 10\%$, 1/2 W	5-TM6879
R46	10 Ω $\pm 10\%$, 1/2 W	24-TM6879

TE = Total Excursion.

Component Ref.	Description	Works Ref.
VARIABLE RESISTORS		
RV1	10 k Ω $\pm$ 20%, 1/4 W	17-TM6873
RV2A	SET OUTPUT 600 Ω 'T' Pad	51-TM6840
RV2B		
RV2C		
RV3	1 k Ω $\pm$ 20%, 1/4 W	2-TM7016
RV4	4.7 k Ω $\pm$ 20%, 1/4 W	3-TM 7016
RV5	1 k Ω $\pm$ 20%, 1/4 W	2-TM7016
RV6A	10 k Ω $\pm$ 2%, 4W	52-TM6840
RV6B	10 k Ω $\pm$ 2%, 4W	
RV6C	5 k Ω $\pm$ 2%, 4W	
RV7	100 Ω $\pm$ 10%, 1 W	53-TM6840
RV8	470 Ω $\pm$ 20%, 1/4 W	2-TM6881
RV9	470 Ω $\pm$ 20%, 1/4 W	2-TM6881
RV10	470 Ω $\pm$ 20%, 1/4 W	2-TM6881
RV11	470 Ω $\pm$ 20%, 1/4 W	2-TM6881
RV12	470 Ω $\pm$ 20%, 1/4 W	2-TM6881
RV13	470 Ω $\pm$ 20%, 1/4 W	2-TM6881
RV14	220 k Ω $\pm$ 20%, 1/4 W	3-TM6881
RV15	220 k Ω $\pm$ 20%, 1/4 W	3-TM6881
RV16	220 k Ω $\pm$ 20%, 1/4 W	3-TM6881
RV17	220 k Ω $\pm$ 20%, 1/4 W	3-TM6881
RV18	220 k Ω $\pm$ 20%, 1/4 W	3-TM6881
RV19	220 k Ω $\pm$ 20%, 1/4 W	3-TM6881
RV20	100 Ω $\pm$ 10%, 1 W	25814-108

CIRCUIT NOTES

1. COMPONENT VALUES

Resistors : No suffix = ohms, k = kilohms, M = megohms.

Capacitors : No suffix = microfarads, p = picofarads.

* value selected during test; nominal value shown.

2. VOLTAGES

Shown in italics. These are d.c. and relative to the +ve supply line (pin 6) unless otherwise stated. Measured with a 20 k Ω /V meter.

3. SYMBOLS

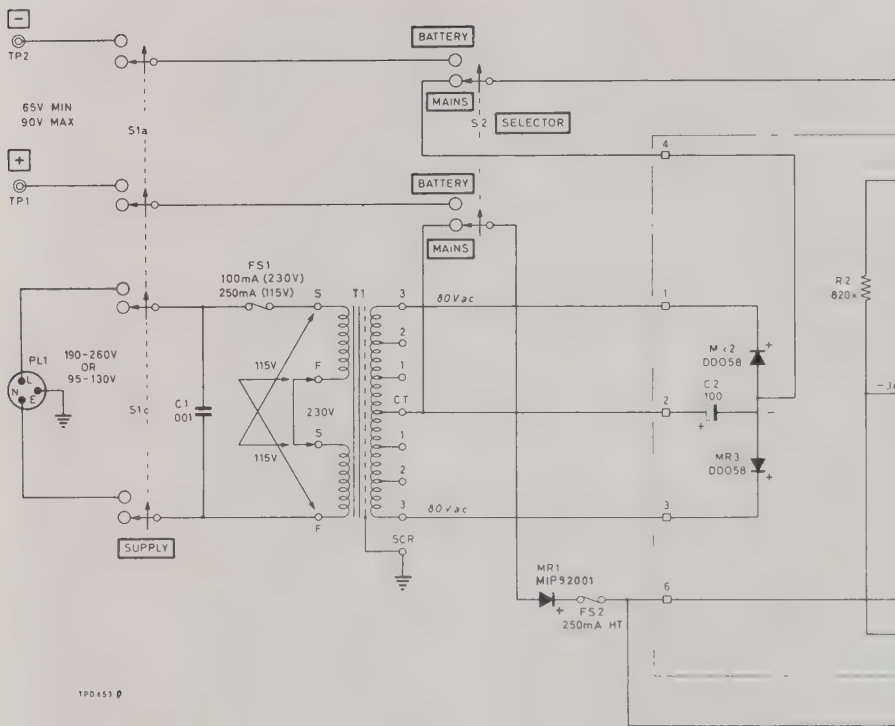
 preset component

 arrow indicates clockwise rotation of knob

 panel marking

 printed board designation

 printed board tag number



1PD 451 0

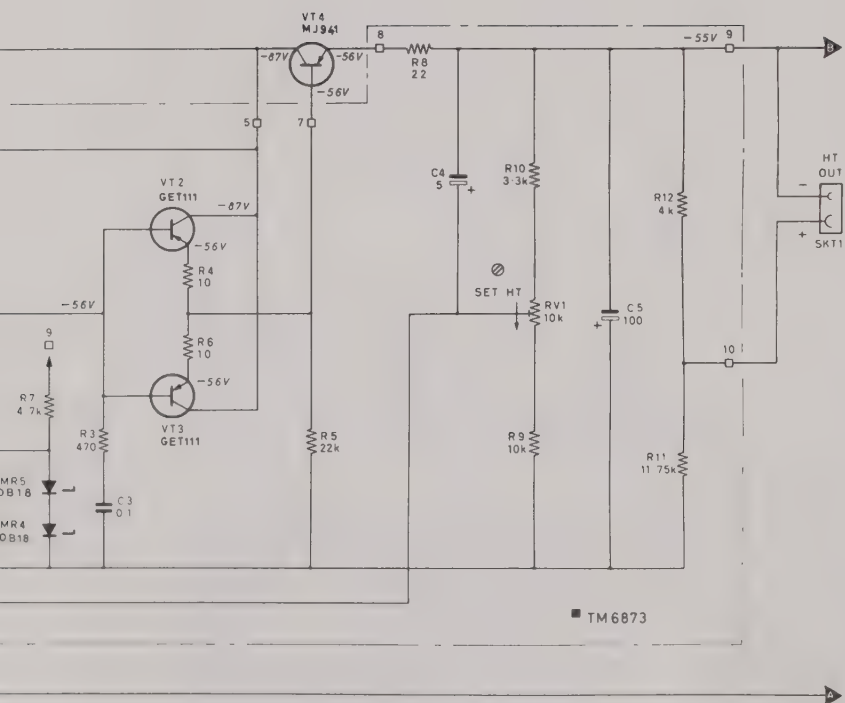


Fig 4.4 POWER SUPPLY

CIRCUIT NOTES

1. COMPONENT VALUES

Resistors : No suffix = ohms, k = kilohms, M = megohms

Capacitors : No suffix = microfarads, p = picofarads.

* value selected during test; nominal value shown.

2. VOLTAGES

Shown in *italics*. These are d.c. and relative to the -ve supply line (pin 12) unless otherwise stated. Measured with a 20 k Ω /V meter.

3. SYMBOLS

 preset component

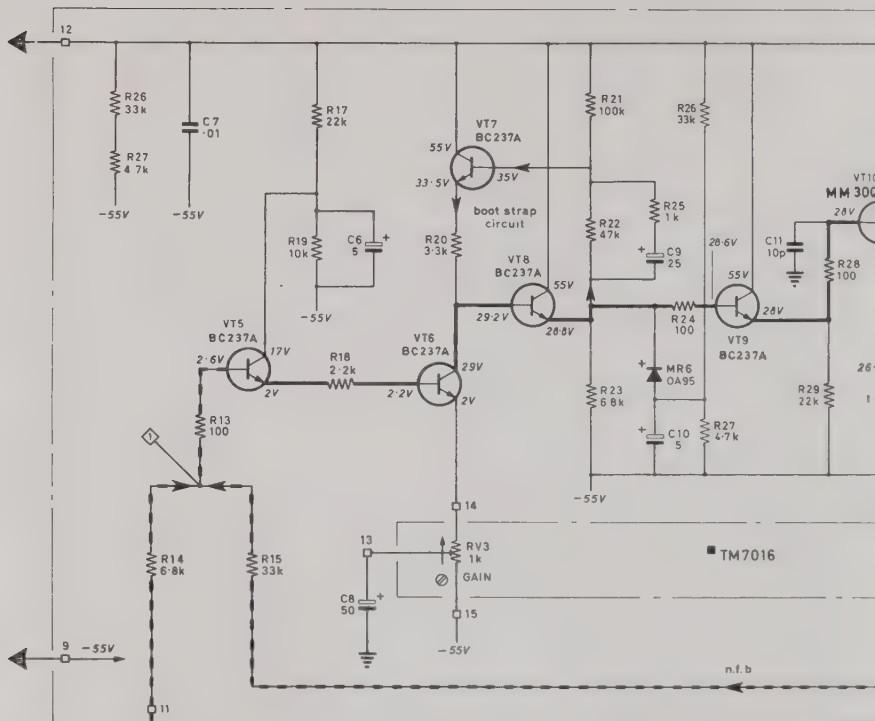
 arrow indicates clockwise rotation of knob

 panel marking

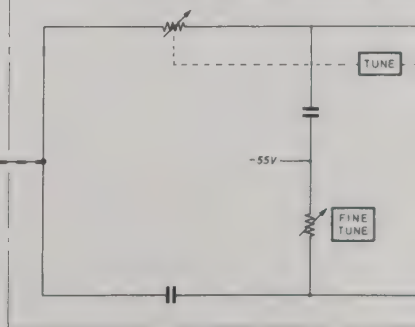
 printed board designation

 printed board tag number

 test point



FUNCTIONAL DIAGRAM OF OSCILLATOR FEEDBACK
SEE FIG 4/6 FOR DETAILED CIRCUIT



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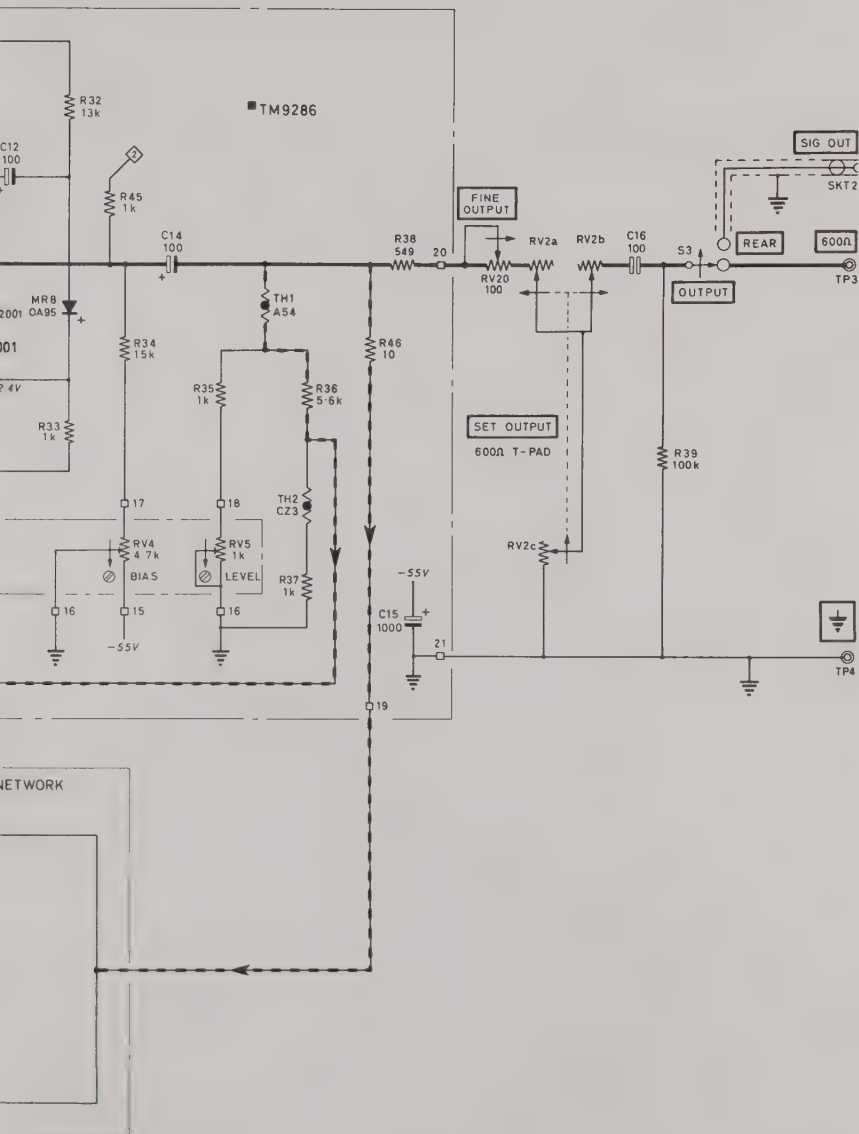


Fig.4-5 OSCILLATOR

CIRCUIT NOTES

1. COMPONENT VALUES

Resistors : No suffix = ohms, k = kilohms, M = megohms

Capacitors : No suffix = microfarads, p = picofarads.

* value selected during test; nominal value shown.

2. SYMBOLS

 preset component

 arrow indicates clockwise rotation of knob

 panel marking

 printed board designation

 printed board tag number

3. SWITCHES

Rotary switches are drawn schematically.

Numbers or letters indicate control knob setting as shown in key diagram.

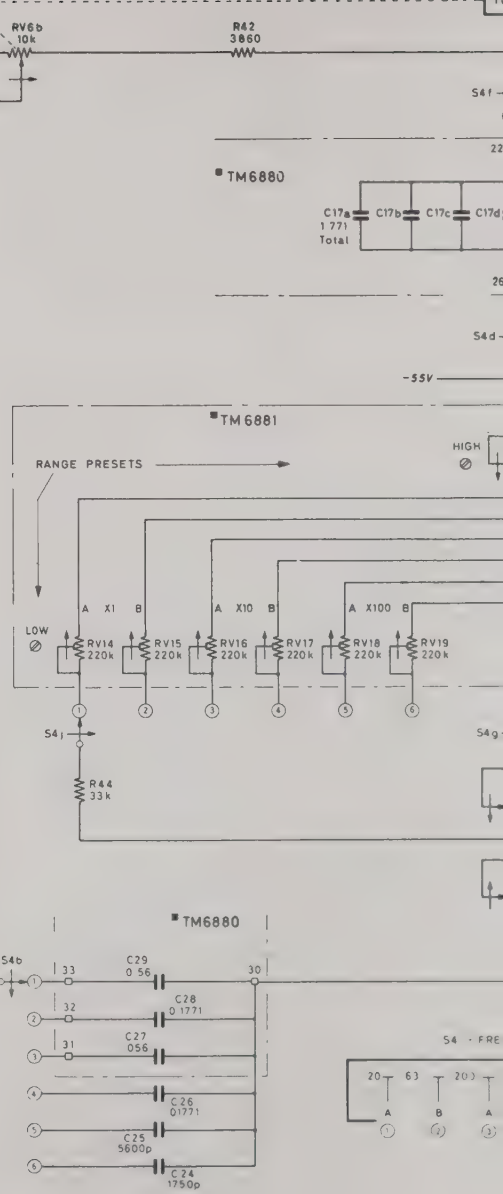
a = 1st section, front

b = 1st section, back

c = 2nd section, front

etc.

TO OSCILLATOR
INPUT FIG 4-5
11
□



81PD456

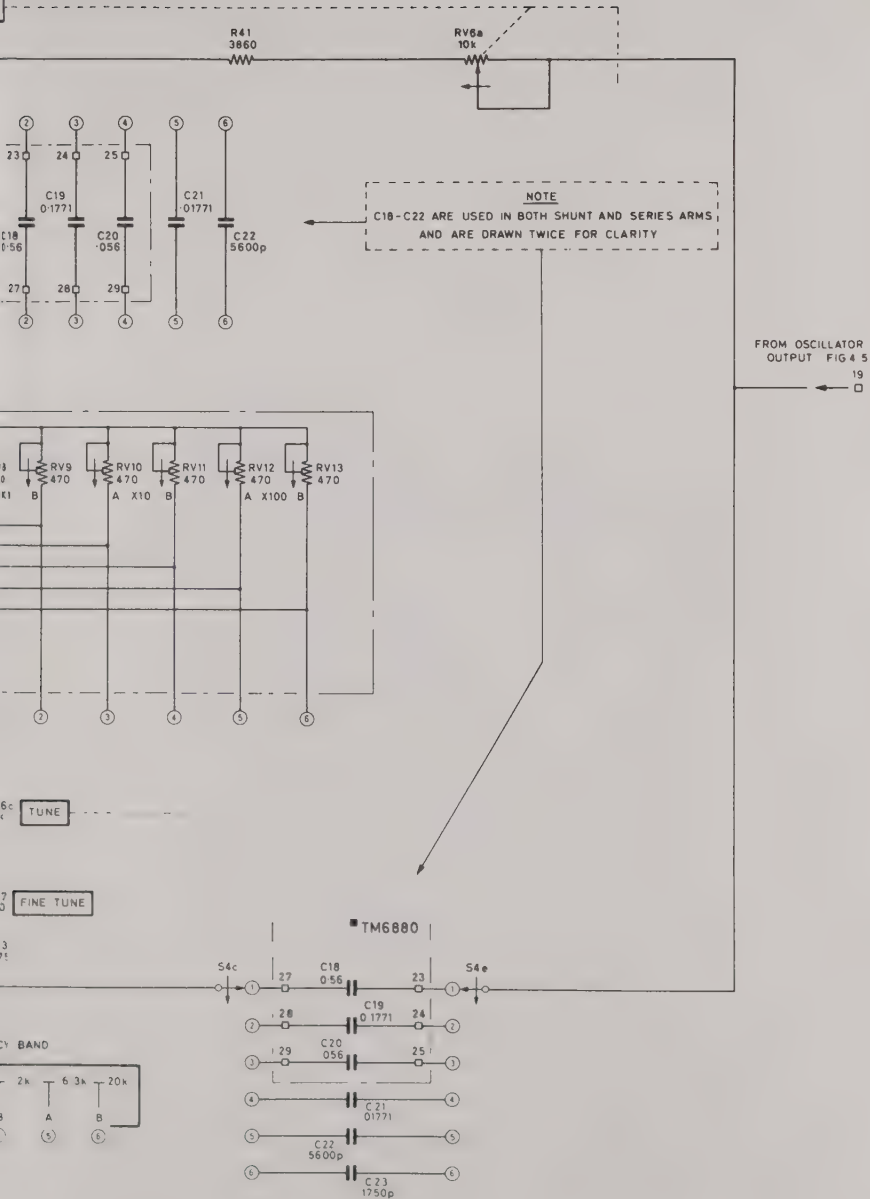


Fig 4.6 OSCILLATOR FEEDBACK NETWORK

Component Ref.	Description	Works Ref.
SWITCHES		
S1	SUPPLY	22-TM6840
S2	BATTERY/MAINS, Double pole, double throw	64-TM6840
S3	OUTPUT, Single pole, double throw	65-TM6840
S4	RANGE	1-TM7057
SOCKETS		
SKT1	H. T. OUT	68-TM6840
SKT2	SIG OUT, Miniature Belling-Lee	66-TM6840
TRANSFORMERS		
T1	Mains	5-TM6840
THERMISTORS		
TH1	A54	48-TM6879
TH2	CZ3	49-TM6879
TERMINALS		
TP1	BATTERY +	6-TM6840
TP2	BATTERY -	6-TM6840
TP3	600 Ω	6-TM6840
TP4	E	6-TM6840

Component Ref.	Description	Works Ref.
TRANSISTORS		
VT1	ACY17	28426-497
VT2	ACY17	28426-497
VT3	ACY17	28426-497
VT4	2N1531	59-TM6840
VT5	BC237A	28455-421
VT6	BC237A	28455-421
VT7	BC237A	28455-421
VT8	BC237A	28455-421
VT9	BC237A	28455-421
VT10	MM 3001	28458-406
VT11	MM 3001	28458-406

OPERATING INSTRUCTIONS
No. EB 2160

for

A.F. Monitored Attenuator

TF 2160

and

TF 2160/I

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MARCONI INSTRUMENTS LIMITED
ST. ALBANS HERTFORDSHIRE ENGLAND

EB 2160
1f - 3/77

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I GENERAL INFORMATION

1.1 INTRODUCTION

The Type TF 2160 is a variable attenuator having a range of 111 dB in 0.1 dB steps. Adjustment is provided by switched unbalanced 600 Ω networks. At the input, a high impedance multi-range voltmeter monitors the applied signal up to 25 V. At the output, a matching transformer can be switched into use to provide a balanced 600 Ω , 150 Ω , or 75 Ω source impedance in place of the 600 Ω unbalanced source impedance provided directly by the attenuation networks; the centre tap of the secondary of the transformer is brought out to a front panel terminal so that the secondary can be connected as required. Using the transformer, the frequency range of the attenuator is 20 c/s to 20 kc/s; without the transformer, it is d.c. to 550 kc/s, except that the voltmeter cannot be used below 20 c/s.

Employing batteries for its voltmeter circuit, the Attenuator is independent of a mains supply.

A shielded adaptor is supplied with the instrument. With this it is possible to convert the output terminals effectively into a BNC coaxial socket outlet.

TF 2160/1 is a version of the instrument that has two parallel connected input sockets at the rear so that two signals can be fed in together. It is in all other respects identical to TF 2160.



Fig. 1.1

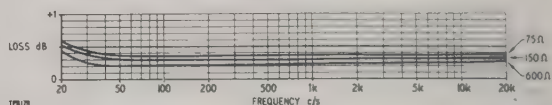
A.F. Monitored
Attenuator
Type TF 2160

1.2 DATA SUMMARY

Frequency Range : 20 c/s to 20 kc/s with balanced output. D.C. to 550 kc/s with unbalanced output.

Attenuation

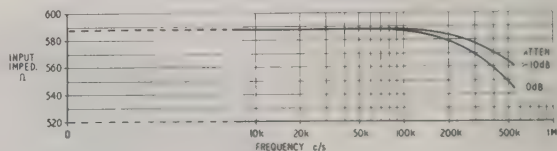
Range : 0 to 111 dB in 0.1 dB steps.
Residual Loss : Unbalanced : Less than 0.01 dB at d.c.
 Balanced : See graph below.



Accuracy : 20 c/s to 20 kc/s: $\pm 1\%$ of dB setting ± 0.2 dB.
 At d.c.: $\pm 1\%$ of dB setting ± 0.01 dB.
 20 c/s to 550 kc/s: $\pm 2\%$ of dB setting ± 0.2 dB.

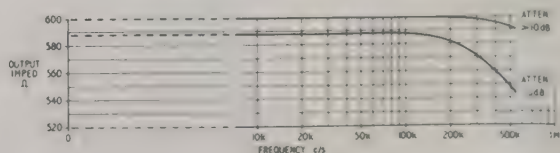
Impedance

Input (with 600 Ω load): 600 Ω unbalanced; varies with frequency and attenuation as follows when voltmeter is switched in.



(With voltmeter switched out the linear part rises to 600 Ω .)

Output (with 600 Ω source): Balanced: 600, 150 and 75 Ω via transformer.
 Unbalanced : 600 Ω ; varies with frequency and attenuation as follows when voltmeter is switched in.



(With voltmeter switched out both the linear parts are at 600 Ω .)

Power Input : 1 W (25 V) maximum, continuous a.c. or d.c.

Frequency Response : Output is flat within ± 0.2 dB from 20 c/s to 20 kc/s, and within ± 1 dB from 20 c/s to 550 kc/s at any attenuator setting, with input meter reading held constant.

Distortion at balanced output with matched load : With +15 dBm (31.6 mW) pure input, output distortion factor does not exceed :
0.1% from 50 c/s to 20 kc/s,
0.3% from 30 c/s to 50 c/s.

Input Voltmeter

Ranges : 1.5, 5, 15, and 25 V full-scale; also marked -6 to +30 dBm.

Accuracy : $\pm 5\%$ of full-scale from 20 c/s to 550 kc/s.

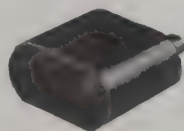
Supply : 8 V, approximately 2 mA, from internal mercury batteries or external source.

Dimensions :	Height	Width	Depth	Weight
	7 3/4 in	5 3/4 in	10 1/2 in	12 1/4 lb
	(19.5 cm)	(14.5 cm)	(27 cm)	(5.6 kg)

Accessories Supplied

Fig. 1.2
Shielded adaptor
Type TB 39868

- (1) One coaxial free plug, Type BNC.
- (2) One coaxial free plug, Belling Lee miniature type L1465/FP/Ag.
- (3) One shielded adaptor, providing BNC socket outlet from terminals, Type TB 39868 (Greenpar Type GE51002).
- (4) Two mercury batteries, Mallory Type TR 233R.



Accessories Available

- (a) Modular rack mounting case Type TM 7010.
- (b) Coaxial lead Type TM 6958.
- (c) Twin lead Type TM 7053.

1.3 ASSOCIATED EQUIPMENT AND ACCESSORIES AVAILABLE

The A.F. Monitored Attenuator TF 2160 belongs to a series of instruments designed in the same size or multiples of this size (the width varying). To enable these units to be mounted together in a standard 19 inch rack case Type TM 7010 is available. The TF 2160 and two other units of the same size (or one other unit twice the width of the TF 2160) can be fitted in line in this case, which has slotted brackets at each end for rack fixing. Unoccupied spaces in the case can be filled by one or more Blank Panel Units Type TM 6844, each $\frac{1}{3}$ of the width of the case; the user can employ these for mounting auxiliary controls and other components if desired.

An instrument that may be used with the TF 2160, and which belongs to the same series, is the A.F. Oscillator TF 2100; this is a low distortion source covering 20 c/s to 20 kc/s. It has the same dimensions as the TF 2160 and can be mounted in another compartment beside the TF 2160 in a TM 7010 case. When the two instruments are together in the case, they can easily be linked between their rear panels; in addition to the signal, the TF 2100 can supply the d.c. requirements of the TF 2160 in place of its batteries. A coaxial lead, Type TM 6958, and a twin lead, Type TM 7053, are available for use as signal and d.c. supply links respectively in these circumstances.

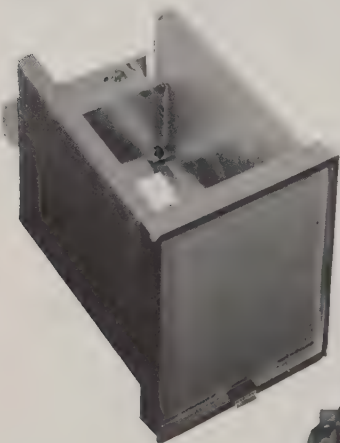
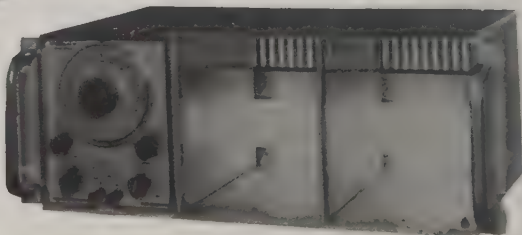


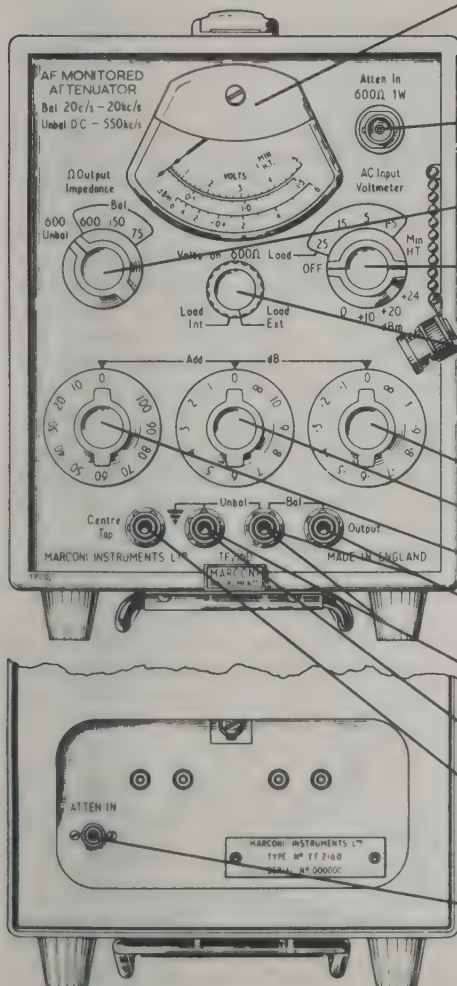
Fig. 1.4
Rack mounting case
Type TM 7010
with one compartment
occupied

Fig. 1.3
Blank Panel Unit
Type TM 6844



2 OPERATION

2.1 CONTROLS AND CONNECTORS



Input voltmeter; read and multiply reading on top or bottom voltage scale according to setting of range switch

ATTEN IN socket; front inlet (BNC)

Ω OUTPUT IMPEDANCE selector

Input meter range switch; switch OFF after use

Termination switch: INT presents matched internal load to attenuator

0.1 dB step switch

1 dB step switch

10 dB step switch

Balanced output terminals

Unbalanced output terminals

Earth

Output transformer centre tap

ATTEN IN socket: additional rear inlet (Belling Lee miniature)

Not shown - Concealed by the rear cover are batteries and a twin socket for d.c. input from them or an external source

Fig. 2.1
Controls and connectors

2.2 PREPARING FOR USE

POWER SUPPLY

Only the input voltmeter in the Attenuator requires a power supply. This is normally provided by two 4V mercury batteries, in series, mounted at the rear of the instrument, concealed by the rear cover.

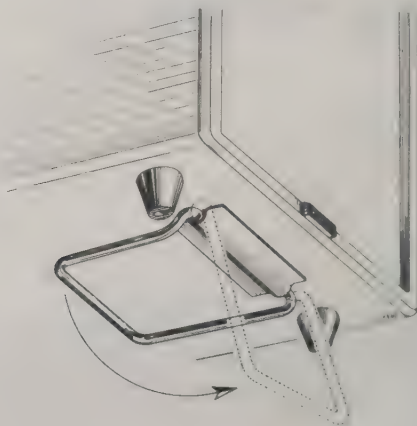
Check that the batteries are providing sufficient voltage. To do this, turn the AC INPUT VOLTMETER switch to MIN HT. The meter should indicate above the MIN HT mark. If it does not, one of the batteries, probably both, should be replaced; see Section 4.2.

The voltmeter can be fed from an external d.c. source instead of the batteries. In particular, an A.F. Oscillator Type TF 2100 may be used as a source. See Sections 2.8 and 2.9.

OPERATING POSITION

Underneath the case, near the front, is a folding stand. This can be pulled down and forward so that it will support the instrument in a tilted position on a bench; see Fig. 2.2. Having the front panel facing upwards, in this manner can make operation easier in some circumstances.

Fig. 2.2
Lowering Stand



For details regarding fitting the instrument with others in a rack-mounting case TM 7010, see Section 2.9.

2.3 APPLYING AN INPUT SIGNAL

Safeguard a sensitive load by initially turning the attenuation controls to maximum before feeding a signal through the Attenuator. Also, set the AC INPUT VOLTMETER switch to a range suitable for the input to be applied; set it to OFF if the input will not be a sine wave. The input should not exceed 25 V, a.c. or d.c.

The inlet ATTEN IN on the front panel is a type BNC socket. An additional, electrically parallel, inlet is provided at the rear, primarily for use when employing the Attenuator with associated equipment in a rack, as described in Section 2.9. This rear inlet is a Belling Lee miniature coaxial socket. If the rear socket is used, cover the front inlet with the cap provided, to prevent leakage.

The input impedance is $600\ \Omega$, providing that the output impedance is matched by the load. If the output is mismatched, the input impedance is still $600\ \Omega$ provided that a substantial amount of attenuation is in use; if the load has a very high or a very low impedance relative to the matching value, the attenuation can be reduced to about 13 dB or less before a 10% variation arises in the input impedance. When the load has a very high impedance, the internal termination should normally be used, and the output will then be approximately matched.

2.4 READING INPUT SIGNAL LEVEL

Turn the AC INPUT VOLTMETER switch clockwise to the most sensitive range that can be employed without the meter deflection exceeding full-scale. Read the meter according to the setting of the switch, as shown by Table 2.1.

TABLE 2.1.

AC INPUT VOLTMETER Switch Setting	Use Scale	Multiply Indication By
25	0-5	x5
15	0-1.5	x10
5	0-5	x1
1.5	0-1.5	x1

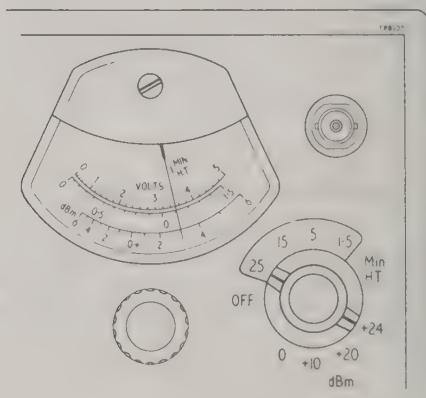
The meter reading is the r.m.s. value of the input voltage, assuming that the input is a sine wave. The reading may be inaccurate if the input is not sinusoidal, or if its frequency is less than 20 c/s.

CAUTION : If it is anticipated that an input will be non-sinusoidal and might exceed 50 V peak, the AC INPUT VOLTMETER switch should be turned to OFF to prevent damage in the voltmeter circuit. Further restriction may be necessary if the voltmeter is fed from an external supply; see Section 2.8.

The meter also has a scale calibrated +6 to -6 dBm. The 0 dBm mark on this scale corresponds to the voltage, on the 0 and 1.5 V scale, that will produce 1 mW input to the Attenuator. When the voltmeter is used on higher voltage ranges, the dBm scale is effectively extended by addition of the dBm increments marked at the range switch positions.

If, at any BAL position, the wanted output is such that less than 10 dB of attenuation is required, first switch in 10 dB and terminate the Attenuator internally or externally before setting the input and reading the meter. Then reduce the attenuation as required, and do not compensate for any rise in meter reading.

Fig. 2.3
Reading of 17.3 V
and 27 dBm input



The dBm reading indicates the power fed into the attenuator networks assuming that the input impedance is 600 Ω . This will not be so if the instrument is mismatched at its outlet and the value of attenuation is low; see Section 2.3.

It will be appreciated that the dBm scale and the dBm markings on the meter range switch can be used to relate in dB different levels of applied signal without regard to the actual values of power concerned.

NOTE : Set the AC INPUT VOLTMETER switch to OFF when you have finished using the instrument and conserve the batteries.

2.5 SETTING OUTPUT IMPEDANCE

The different output impedances available as follows are only obtained providing the input to the Attenuator comes from a 600Ω generator, or providing a substantial amount of attenuation is in use (over 13 dB ensures an output impedance close to the selected nominal value).

The following sections mention the front panel terminals to be used. Each terminal includes a socket for a 4 mm plug, and any pair of adjacent terminals will accept a twin plug having $3/4$ inch pin spacing. Carrying a BNC socket, the adaptor TB 39868 (supplied with the instrument) can be plugged into the two UNBAL terminals to provide good shielding and facilitate employing coaxial leads.

600Ω , 150Ω , or 75Ω BALANCED

- (1) Set the Ω OUTPUT IMPEDANCE switch to whichever of the BAL positions indicates the required source impedance.
- (2) Set the internal termination switch to LOAD EXT.
- (3) Connect the load to the two BAL terminals.

If the BAL terminals alone are used, a floating source is obtained. To balance the source relative to earth (ground), connect the CENTRE TAP terminal to earth. The left-hand UNBAL terminal, which is connected internally to case and chassis, serves as an earth point assuming that the outer of the coaxial inlet socket on the Attenuator is earthed by the input lead.

Under these conditions the matching transformer is in use and the frequency range of the instrument is 20 c/s to 20 kc/s.

600Ω UNBALANCED

- (1) Set the Ω OUTPUT IMPEDANCE switch to 600 UNBAL.
- (2) Set the internal termination switch to LOAD EXT.
- (3) Connect the load to the two UNBAL terminals. The left-hand one, which is connected internally to case and chassis, serves as an earth point assuming that the outer of the coaxial inlet socket on the Attenuator is earthed by the input lead.

Under these conditions the output is obtained directly from the attenuating networks and the frequency range of the instrument extends from d.c. to 550 kc/s (except that the input voltmeter becomes inaccurate below 20 c/s).

150 Ω or 75 Ω UNBALANCED

- (1) Set the Ω OUTPUT IMPEDANCE switch to BAL 150 or BAL 75, according to the required value of source impedance.
- (2) Set the internal termination switch to LOAD EXT.
- (3) Connect the load to the two BAL terminals. Connect one of these terminals to earth, as required. The left-hand UNBAL terminal, which is connected internally to case and chassis, serves as an earth point assuming that the outer of the coaxial inlet socket on the Attenuator is earthed by the input lead. Leave the CENTRE TAP terminal disconnected.

The frequency range is 20 c/s to 20 kc/s.

37.5 Ω or 18.75 Ω

- (1) Set the Ω OUTPUT IMPEDANCE switch to BAL 150 if 37.5 Ω source impedance is required, or to BAL 75 if 18.75 Ω source impedance is required.
- (2) Set the internal termination switch to LOAD EXT.
- (3) Connect the load between one BAL terminal and the CENTRE TAP terminal.

If the above two output terminals alone are used, a floating source is obtained. The load circuit may be arranged to provide balance. Alternatively, one of the terminals can be connected to earth, as required. The left-hand UNBAL terminal, which is connected internally to case and chassis, serves as an earth point assuming that the outer of the coaxial inlet socket on the Attenuator is earthed by the input lead.

NOTE : Although 37.5 Ω and 18.75 Ω are the nominal impedances resulting from the transformer ratios, the transformer is not primarily designed to provide these values, and under these conditions it introduces a significant value of resistance, which raises the impedance by up to approximately 10%.

The frequency range is 20 c/s to 20 kc/s.

2.6 READING ATTENUATION AND OUTPUT

NOTE : Tables of voltage and power ratios corresponding to dB values are provided at the end of this handbook.

ATTENUATION

Set the three attenuation-step switches to obtain the required amount of attenuation. Add the readings of the three dials to find the value of the attenuation.

This value is the extent to which the power reaching the load is attenuated relative to that fed into the Attenuator, providing that the nominal output impedance of the instrument is matched by the impedance of the load. Changes of attenuation are given accurately by the difference between readings providing that, either (i) the nominal output impedance of the Attenuator is matched by the load, or (ii) the generator feeding the Attenuator has a source impedance of $600\ \Omega$.

To find the exact value of attenuation at any BAL position, add the residual loss shown in Data Summary to the sum of the dial readings. If the attenuation is less than 10 dB see the precaution given in Section 2.4.

When all the dials are turned to 0 dB; (i) if the Ω OUTPUT IMPEDANCE switch is set to 600 UNBAL, there is a direct connection between the source feeding the Attenuator and the load on the UNBAL terminals, except for the 0.2 dB network, which presents a low series value and a high shunt value of resistance; (ii) if the Ω OUTPUT IMPEDANCE switch is set to any of the BAL positions, the source feeding the Attenuator is directly connected to the primary of the internal matching transformer via the preceding blocking capacitor.

Two of the dials have ∞ positions. At these, the signal path through the Attenuator is completely broken.

POWER OUTPUT

To find the output power being fed to a matched load, subtract the total dB reading of the three dials from the dBm value of input power indicated by the input meter and its range switch.

VOLTAGE OUTPUT

If the output impedance is arranged to be $600\ \Omega$ and the load matches this value, the output voltage developed across the load is simply the input voltage reduced by the total attenuation reading. The output voltage is therefore the input voltage multiplied by the appropriate factor found from dB tables. Alternatively, the chart given in Fig. 2.4 shows the output voltage across a $600\ \Omega$ load corresponding to the dBm value of output read from the meter and dials.



Fig. 2.4 Output voltage corresponding to dBm when output impedance and load are $600\ \Omega$

If the output impedance is adjusted to any of the other possible values and the load matches this value, then, although the attenuation of power is still simply that read from the dials as described above, some dB correction must be added to determine the output voltage. This correction represents the voltage step-down ratio of the output matching transformer. Thus :

Output voltage across a matched load, $V_{om} = (A + R)$ dB below V_{in}

where

A is the total attenuation indicated by the dials, dB.

R is the voltage step-down ratio of the output matching transformer, in dB

V_{in} is the input voltage read on the input meter.

The value of R, the transformer voltage ratio in dB, for different values of output impedance, is given in Table 2.2.

It is possible to use the chart in Fig. 2.4 when the output impedance and matching load have a value less than 600Ω providing that the voltage derived from the chart is reduced by the appropriate voltage step-down ratio given in Table 2.2. To do this, find the output voltage on the chart as if the output impedance and load is 600Ω and then read off the voltage R dBm lower.

TABLE 2.2

Output Impedance Ω	Ω OUTPUT IMPEDANCE Switch position	Terminals Connected to Load	Voltage Step-Down Ratio	Voltage Step-Down dB(R)
600	600 UNBAL	UNBAL	1:1	0
600	BAL 600	BAL	1:1	0
150	BAL 150	BAL	1:0.5	6
75	BAL 75	BAL	1:0.35	9
37.5	BAL 150	One BAL and CENTRE TAP	1:0.25	12
18.75	BAL 75	One BAL and CENTRE TAP	1:0.177	15

OUTPUT TO MISMATCHING LOAD

If the load connected to the Attenuator has an impedance differing from any of the output impedances obtainable on the instrument, it is possible to find the voltage across such a load by applying a correction to the value of voltage that would be developed if the load matched. This correction can be derived from the general expression for the voltage developed across a load fed from a source of known impedance, i.e.,

$$\text{Voltage across load} = \frac{E \times R_L}{R_O + R_L}$$

where

E is the e.m.f. or open-circuit voltage of the source,
 R_O is the output impedance of the source,
 R_L is the load impedance.

It will be seen that when the load matches the source, the voltage developed across it is half the value of E , and that if the load is greater or less than the output impedance, the voltage across the load is greater or less than half of E . This variation in voltage relative to the value when the load is matched, expressed in dB, is a correction that can be applied to the expression for V_{om} above, and is given by the chart in Fig. 2.5, thus

$$\text{Output voltage across load, } V_o = (A + R + M) \text{ dB below } V_{in}$$

where

A is the total attenuation indicated by the dials, dB.

R is the voltage step-down ratio of the output matching transformer, in dB, see Table 2.2

M is the correction, in dB, depending on the relation of the load R_L to the output impedance R_O ; see Fig. 2.5. When R_L exceeds

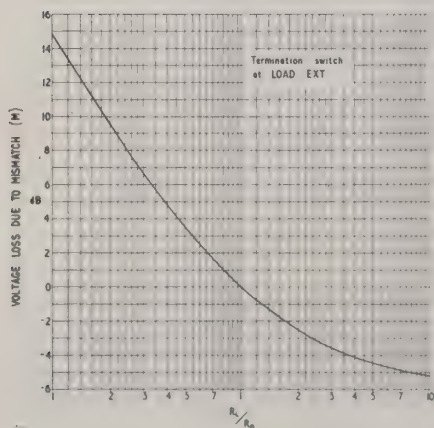


Fig. 2.5
Mismatch loss - switched to EXT

R_O , M is negative and should be subtracted from $A + R$.
 V_{in} is the input voltage, read on the input meter, applied from a 600 Ω generator; see following Notes.

NOTE : The corrections given for a mismatching load are not valid unless the actual output impedance of the Attenuator is the same as the nominal value. To ensure this, the input should be fed from a 600 Ω generator, or the attenuation dial readings should be kept above 13 dB.

: When the load does not match the output impedance, if the attenuation employed is not substantial, the input impedance of the Attenuator may differ from 600 Ω . If this is suspected, temporarily introduce an extra 20 dB attenuation to obtain the reading of V_{in} valid for use in the preceding expressions.

If the load impedance is particularly high compared with the output impedance, turn the internal termination switch to LOAD INT. This introduces an internal resistor that acts as a matching load irrespective of the setting of the Ω OUTPUT IMPEDANCE switch. The internal load will be effectively in parallel with the external load; but, if the latter has a high value, the resultant value of the combination will differ little from the matching value. This has the advantage that it can make a correction for mismatching unnecessary in finding the output voltage, and it permits the attenuation to be adjusted to low values without effect on the input meter reading. If the external load is not very much greater in value than the output impedance, and the internal load is switched in, a correction from the chart in Fig. 2.6 must be added to find the voltage across the load, as follows

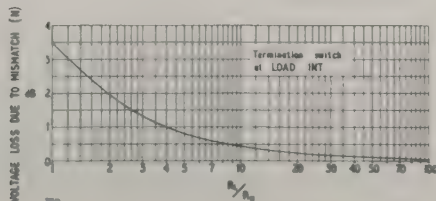
$$\text{Voltage across load} = (A + R + N) \text{ dB below } V_{in}$$

where

A, R, and V_{in} are as defined previously,

N is the correction, depending on the relation of the load to the output impedance; see Fig. 2.6.

Fig. 2.6
Mismatch loss -
switched to INT



2.7 USING OUTPUT MATCHING TRANSFORMER TO OBTAIN A VOLTAGE STEP-UP

The transformer in the Attenuator can be employed as a voltage step-up device at audio frequencies by applying a signal to the BAL terminals normally connected to a load, and by taking output from the front or rear coaxial socket, ATTEN IN, normally used as an inlet. One BAL terminal, and the CENTRE TAP terminal can also be used for applying an input. The nominal voltage ratios and impedance ratios obtainable as shown in Table 2.3.

TABLE 2.3

Terminals Used As Inlet	Ω OUTPUT IMPEDANCE Switch Position	Voltage Step-Up Ratio	Impedance Step-Up Ratio	Output Imp- edance if Source is 600 Ω
BAL	BAL 600	1:1	1:1	600 Ω
BAL	BAL 150	1:2	1:4	2.4 k Ω
BAL	BAL 75	1:2.8	1:8	4.8 k Ω
One BAL and CENTRE TAP	BAL 600	1:2	1:4	2.4 k Ω
One BAL and CENTRE TAP	BAL 150	1:4	1:16	9.6 k Ω
One BAL and CENTRE TAP	BAL 75	1:5.7	1:32	19.2 k Ω

In most cases, it is necessary to set all the attenuation dials to 0 in order that the attenuation circuits should not load the output obtained in this manner, but the attenuation controls can be turned to other positions to reduce and adjust the output if required.

The input voltmeter of the Attenuator can be used to monitor the output, but its shunt impedance (approximately 30 k Ω) is significant in comparison with some of the values of output impedance which are obtained by this inverted use of the transformer, and consequently it may lower the voltage and effective output impedance obtained. To disconnect the voltmeter circuit, turn the meter range switch to OFF. Note the information and Caution applying to the voltmeter given in Section 2.4.

The transformer is not particularly designed to operate in this fashion, and in doing so it has a relatively poor frequency response, which is worst at the highest ratios. However, the 'input' voltmeter, used to monitor the output, facilitates making adjustments to compensate for variation in the output. The transformer also causes distortion to become serious at low frequencies (below 400 c/s) when high step-up ratios are used.

2.8 USING AN EXTERNAL D.C. SUPPLY

The Attenuator only needs a power supply for its input voltmeter circuit. This requirement is normally met by the mercury batteries mounted inside the rear of the instrument. But an external d.c. source can be employed. A supply of approximately 2 mA at a potential of 6 to 9 V is required. This should be fed to the two-way socket otherwise occupied by the plug connected to the battery holder.

To gain access to this d.c. inlet, withdraw the two coin-slotted screws from the rear cover and remove the cover (leaving the instrument loose in its case). The rear cover can be refitted (securing the instrument) with its aperture - normally giving access to the rear coaxial inlet - at the top, so that leads can easily be connected to the d.c. two-way socket; though it should be noted that any batteries in the instrument will not be retained with the cover fitted in this way. The larger socket on the d.c. inlet is for the positive connection from the supply. A Carr Fastener type 76/046 two-way plug fits the d.c. inlet.

An external d.c. supply can be floating; or, it can have either polarity earthed, so that one of the d.c. input connections can have a potential of up to 9 V relative to earth. In the latter circumstances, the a.c. signal input reaching the voltmeter should not exceed 41 V peak or damage may occur, whereas the input to the voltmeter can be 50 V peak with a floating external supply as with an external battery; see Caution in Section 2.4.

2.9 MOUNTING IN CASE TM 7010

FITTING PROCEDURE

To fit the Attenuator in a rack-mounting case Type TM 7010, proceed as follows :-

- (1) Remove the instrument from its case; see Section 4.3.
- (2) Fit the rear cover of the rack-mounting case into the slots provided at the back of the case. The large aperture should be lower than the ventilating grating. (The bottom of the case is the separate panel assembled to the rest).

- (3) Select the compartment to be occupied by the Attenuator (removable divisions separate the case into three sections) and slide the Attenuator in backwards, keeping its rear end up to avoid the screws in the bottom of the case.
- (4) Insert the two coin-slotted screws, originally in the case of the Attenuator, through the appropriate holes in the rear cover of the rack-mounting case, and tighten them in the bar at the rear of the Attenuator.

LINKING TO AN A.F. OSCILLATOR TF 2100

The subsidiary coaxial inlet at the rear of the Attenuator can conveniently be linked to the coaxial outlet at the rear of an A.F. Oscillator Type TF 2100. The Belling Lee miniature coaxial sockets are accessible through the aperture in the rear cover of the case Type TM 7010. A coaxial lead, Type TM 6958, for this purpose is available as an optional accessory.

It is also possible to provide the d.c. supply for input voltmeter circuit of the Attenuator from the TF 2100 when the two instruments are fitted together in a case TM 7010. To do this, insert both units in the case, the Attenuator on the right-hand side of the Oscillator, with the rear cover of the case off. Remove the batteries from the rear of the Attenuator. Remove the battery supply plug from the two-way socket on the rear of the Attenuator, and link this socket instead with the HT OUT socket on the rear of the A.F. Oscillator; a lead, TM 7053, for this purpose is also available as an optional accessory. Fit the rear cover of the case and secure the units as described above.

3 CIRCUIT SUMMARY

The A.F. Monitored Attenuator comprises three divisions: a 111 dB step attenuator, an input voltmeter, and an output circuit including a multi-ratio matching transformer. The arrangement is shown in the block diagram, Fig. 3.1. The circuit of the step attenuator is shown in Fig. 4.2 and the circuit of the remainder of the instrument is shown in Fig. 4.3.

3.1 111 dB STEP ATTENUATOR

The step attenuator provides a range of 111 dB in three decades. The three controls of these permit adjustment in steps of 10 dB from 0 up to 100 dB, in steps of 1 dB from 0 to 10 dB, and in steps of 0.1 dB from 0 to 1 dB. The last two decades can also be switched to completely break the signal path through the instrument.

Each decade uses four symmetrical T networks, which are switched into use alone or in different series combinations to provide ten steps of attenuation. Each network has a characteristic impedance of $600\ \Omega$. High-stability resistors are used throughout. The complete step attenuator assembly is in a separate box.

Signals applied to the instrument reach the step attenuator directly via the rear of front panel ATTEN IN sockets, the two inlets being in parallel.

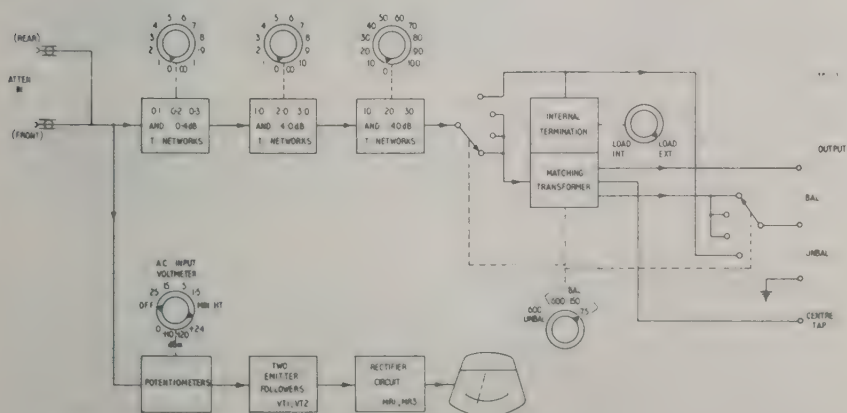


Fig. 3.1 Block diagram of A.F. Monitored Attenuator

3.2 INPUT VOLTMETER

Connected in parallel with the inlets to the step attenuator, the input meter measures the voltage applied to the instrument.

The basic voltmeter consists of two germanium diodes, MR1 and MR3, in a voltage doubling rectifier circuit, feeding the moving-coil meter M1. The rectifier circuit is preceded by two transistors, VT1 and VT2, arranged as emitter followers in cascade. These present a higher effective input impedance for the voltmeter and isolate the distorting effects due to rectification.

The first transistor, VT1, receives the input voltage of the Attenuator via potentiometer circuits selected by the range switch, SC. On the most sensitive range, one potentiometer alone is used, consisting of R1 in series with RV1 in one arm and the input impedance of the first emitter follower circuit. On each of the other three ranges this potentiometer is preceded by one other supplementary potentiometer, selected by the switch from the three formed by: R4, RV4, and R15; R3, RV3, and R14; R2, RV2, and R13. The potentiometer arms have shunt capacitors, some trimmers, which preserve the required voltage drop at the higher frequencies.

If switch SC is turned to OFF, the voltmeter is disconnected and ceases to monitor the input to the instrument.

The transistors receive their d.c. supply (normally from mercury batteries mounted within the rear of the instrument) via socket SKT B and reverse-polarity protection diode MR2. The voltage of the supply is checked at the MIN HT position of switch SC.

The voltmeter circuit has no d.c. connection to the rest of the instrument. It has a reference point with an a.c. tie to chassis via C10, and there is a d.c. blocking capacitor, C6, in series with the signal input path.

3.3 OUTPUT MATCHING CIRCUIT

This part of the instrument receives the output of the step attenuator. It consists mainly of a multi-ratio matching transformer and switching arrangements by which the taps on the secondary of the transformer are selected or the transformer is bypassed. The output circuit arrangement is shown in Fig. 3.2; for simplicity, the internal termination and its switching referred to in this section, are omitted from the diagram.

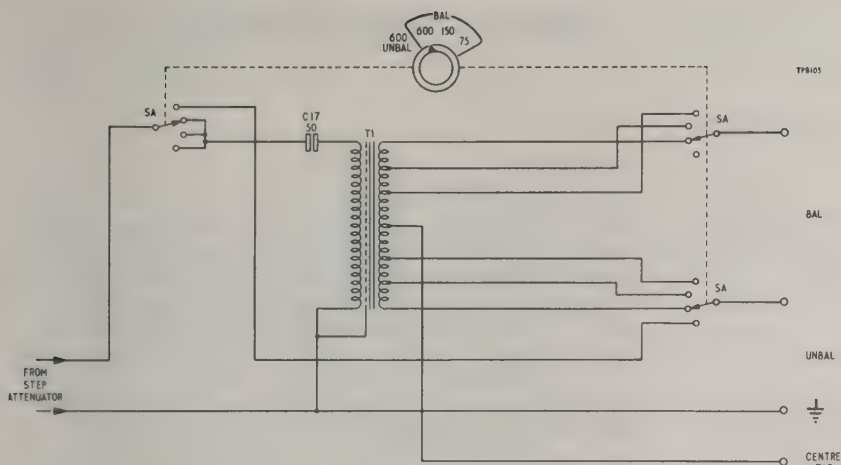


Fig. 3.2 Output Circuit (less switched internal load)

At three positions of the output impedance selector switch, SA, the output of the step attenuator is applied to the primary of the matching transformer, T1, via a d.c. blocking capacitor, C17. At these three positions SA also connects in turn three pairs of taps on the secondary of the transformer to the BAL output terminals on the front panel, so that output impedances of 600 Ω , 150 Ω , and 75 Ω are obtained. The secondary is floating and has a centre tap connected to another terminal on the front panel.

At a fourth position of SA, the output of the step attenuator is fed to the UNBAL terminals; the transformer is bypassed in this case. The switching arrangements are such that one UNBAL terminal is one that serves as a BAL terminal at the other positions of SA. The other UNBAL terminal is a chassis connection.

A 600 Ω resistor, R19, can be switched into use as a matching load for the Attenuator. This can be done at any position of the impedance selector, SA. The switching arrangements of SA are such that at the three positions where different balanced output impedances are obtained, R19 is connected via SB across the 600 Ω taps of the transformer secondary.

4 MAINTENANCE NOTES

4.1 GENERAL

This part of the handbook provides guidance where it is most likely to be needed in servicing the instrument. Should further information be required, beyond that given in this book, please write or phone our Service division, or nearest Area Office or Agent (for addresses, see rear cover). Always mention the type number and serial number of your instrument.

4.2 BATTERY CHECK AND REPLACEMENT

From time to time in a period of using the instrument, particularly at the beginning and end, check the battery voltage by turning the AC INPUT VOLTMETER switch to MIN HT. The meter should then indicate above the MIN HT mark. Remember to turn the switch to OFF before storing the instrument.

If the meter reads below the MIN HT mark, it is advisable to replace both the batteries, assuming each has had the same amount of use. To replace the batteries, withdraw the two coin-slotted screws at the rear of the Attenuator, remove the rear cover, and lift the old batteries from the holder, which will be seen at the back of the instrument. Fit replacement batteries - Mallory Type TR233R - so that the polarity markings on them correspond in position with those on the instrument.

4.3 ACCESS TO COMPONENTS

REMOVING CASE

To remove the case of the A. F. Monitored Attenuator :

- (1) Withdraw the coin-slotted screws from the rear of the instrument. Remove the rear cover if loose.
- (2) Slide the instrument forward from its case. Alternatively, the front panel can be rested face downwards on a soft surface and the case lifted off.

The three divisions of the Attenuator can now be seen: the step attenuator box at the bottom; the input voltmeter box behind the voltmeter range switch; and, on the other side, the matching transformer box. See Fig. 4.1.

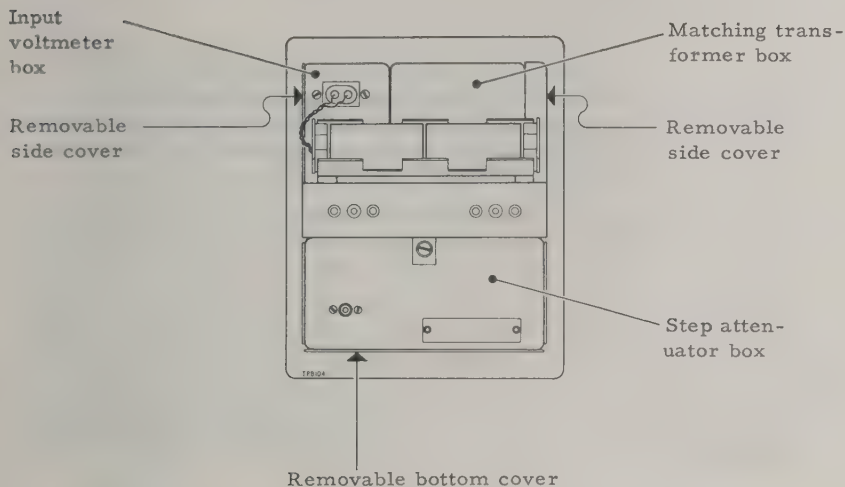


Fig. 4.1 Rear View with case removed

STEP ATTENUATOR BOX

When the case is removed, the components of the step attenuator can be examined and limited access can be obtained by removing the bottom cover of the step attenuator box. To do this, withdraw the ten 6 BA screws that hold it.

To remove the step attenuator box completely :

- (1) Remove the bottom cover of the box as described above.
- (2) Remove the battery holder and bar at the back of the instrument by withdrawing the two 4 BA countersunk screws in the bar.

- (3) Slacken the 4 BA socket-headed set screws in all the control knobs and remove the knobs.
- (4) Disconnect the meter, release the meter clamp (behind the front panel), and remove the meter.
- (5) Withdraw the four countersunk screws in the front panel surround and remove the surround.
- (6) Remove the front panel mask - now free.
- (7) Remove the side cover of the voltmeter box, by withdrawing the two screws that hold it. Unplug the coaxial connector to the step attenuator box and withdraw the 6BA screw securing the attenuator box to the voltmeter box. Be careful not to lose the spacer between the two units which may fall out when the screw is removed.
- (8) Disconnect from the front panel terminals, and from the step attenuator, the five leads that enter the step attenuator box through a hole near the front. Also unsolder the connection to the front panel earth terminal.
- (9) Slacken the screw entering the matching transformer box, and withdraw the screw entering the step attenuator box, in the small bar joining the rear of the two boxes. Swing the bar aside.
- (10) Unscrew and remove the hexagon-headed bushes through which the shafts of the three attenuation controls enter the instrument while supporting the step attenuator box, which will then be freed.

When the attenuator box is separated from the instrument, the sides of the box can be detached by withdrawing the screws and nuts that hold them.

INPUT VOLTMETER BOX

To examine the components in the voltmeter box (behind the voltmeter range switch), withdraw the two 6 BA screws that hold the side cover of the box and remove the cover.

The two boards carrying the majority of the components are held in position by the four, outer, corner screws in the larger board.

MATCHING TRANSFORMER BOX

To obtain access to the components in this box, withdraw the two 6 BA screws holding its side cover and remove the cover.

4.4 CLEANING ROTARY SWITCHES

If it is necessary to clean the contacts of any of the rotary switches, this should be done with benzine (not carbon tetrachloride), and the contacts should afterwards be wiped with a suitable lubricant, such as Electrolube No. 1, manufactured by Electrolube Ltd., Slough, Bucks., England.

4.5 SEMICONDUCTORS

Table 4.1 shows the circuit reference numbers, type numbers, and connection diagrams of the transistors and semiconductor diodes used in the instrument. Some alternative types are also given, particularly those which may be fitted when the instrument is supplied.

TABLE 4.1

Circuit Ref. No.	Circuit	Type	Alternatives	Connections Diagram
VT1, VT2	Fig. 4.3	2N1748A		
MR1, MR3	Fig. 4.3	GEX66		
MR2	Fig. 4.3	OA95	HG1005 1G26	

4.6 WORKING VOLTAGES

Only the two transistors, VT1 and VT2, in the input voltmeter circuit employ a power supply (the battery mounted in the instrument). The two transistors are used as direct-coupled emitter followers, and consequently the d.c. voltage at the emitter of each should normally be approximately the same as that at the base of the first, VT1.

The voltages in Table 4.2 are representative of those to be expected if the battery gives 8.5 V and measurements are made with a meter having a sensitivity of 20 k Ω per volt (e.g. an Avometer 8) set to its 10 V range.

TABLE 4.2

Transistor voltages relative to positive d. c. supply line

Transistor Electrode	Measured On	Volts
	Battery	-8.5
VT1 base	R6	-4.5
VT1 emitter	R7	-4.55
VT2 emitter	R8	-4.3

4.7 PRESETS

Only the voltmeter circuit has preset controls. If it is necessary to change components in the input voltmeter, check afterwards that the presets are set correctly if the best accuracy is required, although it is unlikely that much readjustment will be needed.

To check and, if necessary, adjust the presets :

- (1) Remove the plastic plate beneath the trimming-hole mask, on the top of the voltmeter box, after withdrawing the screws at the corners of the mark. (One screw at the rear can be left in position, but slackened, and the plastic plate swung clear.)
- (2) Turn the AC INPUT VOLTMETER switch to 1.5 V. Apply to the Attenuator inlet a 1 kc/s sine wave; adjust this input to 1.5 V r.m.s., measured on an external standardized valve voltmeter; and set RV1 so that the meter on the Attenuator indicates 1.5 V exactly.
- (3) Apply a 500 kc/s sine wave to the Attenuator; adjust the input to 1.5 V r.m.s., measured on the external standardized meter; and set C1 so that the meter on the Attenuator indicates 1.5 V.
- (4) Turn the switch to 5 V and repeat (2) and (3) with an input of 5 V r.m.s., measured on the external standardized meter; but adjust RV4 and C4, at 1 kc/s and 550 kc/s respectively, for an indication on the Attenuator of 5 V exactly.

- (5) Turn the switch to 15 V and repeat (2) and (3) with an input of 15 V r.m.s., measured on the external standardized meter; but adjust RV3 and C3, at 1 kc/s and 550 kc/s respectively, for an indication on the Attenuator of 15 V exactly.
- (6) Turn the switch to 25 V and repeat (2) and (3) with an input of 25 V r.m.s., measured on the external standardized meter; but adjust RV2 and C2, at 1 kc/s and 550 kc/s respectively, for an indication on the Attenuator of 25 V exactly.

COMPONENT LIST
for
STEP ATTENUATOR (Fig. 4.2)

Circuit Ref.	Description	Works Ref.
RESISTORS		
R1	$3.45 \Omega \pm 0.05 \Omega$, $1/4 \text{ W}/70^{\circ}\text{C}$	10-TM6918/2
R2	$52.1 \text{ k}\Omega \pm 1\%$, $1/4 \text{ W}/70^{\circ}\text{C}$	27-TM6918/2
R3	$3.45 \Omega \pm 0.05 \Omega$, $1/4 \text{ W}/70^{\circ}\text{C}$	10-TM6918/2
R4	$6.91 \Omega \pm 1\%$, $1/4 \text{ W}/70^{\circ}\text{C}$	11-TM 6918/2
R5	$26.1 \text{ k}\Omega \pm 1\%$, $1/4 \text{ W}/70^{\circ}\text{C}$	26-TM6918/2
R6	$6.91 \Omega \pm 1\%$, $1/4 \text{ W}/70^{\circ}\text{C}$	11-TM6918/2
R7	$10.36 \Omega \pm 1\%$, $1/4 \text{ W}/70^{\circ}\text{C}$	12-TM6918/2
R8	$17.4 \text{ k}\Omega \pm 1\%$, $1/4 \text{ W}/70^{\circ}\text{C}$	25-TM6918/2
R9	$10.36 \Omega \pm 1\%$, $1/4 \text{ W}/70^{\circ}\text{C}$	12-TM6918/2
R10	$13.8 \Omega \pm 1\%$, $1/4 \text{ W}/70^{\circ}\text{C}$	14-TM6918/2
R11	$13 \text{ k}\Omega \pm 1\%$, $1/4 \text{ W}/70^{\circ}\text{C}$	24-TM6918/2
R12	$13.8 \Omega \pm 1\%$, $1/4 \text{ W}/70^{\circ}\text{C}$	14-TM6918/2
R13	$34.5 \Omega \pm 1\%$, $1/4 \text{ W}/70^{\circ}\text{C}$	15-TM6918/1
R14	$5.20 \text{ k}\Omega \pm 1\%$, $1/4 \text{ W}/70^{\circ}\text{C}$	23-TM6918/1
R15	$34.5 \Omega \pm 1\%$, $1/4 \text{ W}/70^{\circ}\text{C}$	15-TM6918/1
R16	$68.8 \Omega \pm 1\%$, $1/4 \text{ W}/70^{\circ}\text{C}$	17-TM6918/1
R17	$2.58 \text{ k}\Omega \pm 1\%$, $1/4 \text{ W}/70^{\circ}\text{C}$	22-TM6918/1
R18	$68.8 \Omega \pm 1\%$, $1/4 \text{ W}/70^{\circ}\text{C}$	17-TM6918/1
R19	$102.6 \Omega \pm 1\%$, $1/4 \text{ W}/70^{\circ}\text{C}$	18-TM6918/1
R20	$1.7 \text{ k}\Omega \pm 1\%$, $1/4 \text{ W}/70^{\circ}\text{C}$	21-TM6918/1
R21	$102.6 \Omega \pm 1\%$, $1/4 \text{ W}/70^{\circ}\text{C}$	18-TM6918/1
R22	$135.7 \Omega \pm 1\%$, $1/4 \text{ W}/70^{\circ}\text{C}$	20-TM6918/1
R23	$1.26 \text{ k}\Omega \pm 1\%$, $1/2 \text{ W}/70^{\circ}\text{C}$	33-TM6918/1
R24	$135.7 \Omega \pm 1\%$, $1/4 \text{ W}/70^{\circ}\text{C}$	20-TM6918/1
R25	$312 \Omega \pm 1\%$, $1 \text{ W}/70^{\circ}\text{C}$	38-TM 6918
R26	$422 \Omega \pm 1\%$, $1/2 \text{ W}/70^{\circ}\text{C}$	32-TM6918

Circuit Ref.	Description	Works Ref.
RESISTORS (continued)		
R27	$312\ \Omega \pm 1\%$, 1 W/70°C	38-TM6918
R28	$491\ \Omega \pm 1\%$, 1 W/70°C	39-TM6918
R29	$121\ \Omega \pm 1\%$, 1/4 W/70°C	19-TM6918
R30	$491\ \Omega \pm 1\%$, 1 W/70°C	39-TM6918
R31	$563\ \Omega \pm 1\%$, 1 W/70°C	40-TM6918
R32	$38.0\ \Omega \pm 1\%$, 1/4 W/70°C	16-TM6918
R33	$563\ \Omega \pm 1\%$, 1 W/70°C	40-TM6918
R34	$588\ \Omega \pm 1/2\%$, 1 W/70°C	41-TM6918
R35	$12.0\ \Omega \pm 1/2\%$, 1/4 W/70°C	13-TM6918
R36	$588\ \Omega \pm 1/2\%$, 1 W/70°C	41-TM6918
SWITCHES		
SA	0-100 dB	1-TM6918
SB	0-10 dB	2-TM6918/1
SC	0-1 dB	2-TM6918/2
SOCKETS		
SKTA	ATTEN IN (Rear), Miniature Belling-Lee	25-TM6883
SKTB	ATTEN IN (Internal), Miniature Belling-Lee	25-TM6883

COMPONENT LIST

for

INPUT VOLTMETER and OUTPUT CIRCUIT (Fig. 4.3)

Circuit Ref.	Description	Works Ref.
BATTERIES		
BY101	4 V, Mallory TR233R	23-TF2160
BY102	4 V, Mallory TR233R	23-TF2160
CAPACITORS		
C1	4-20 pF Trimmer	18-TM7013
C2	3-12 pF Trimmer	18-TM7013
C3	3-12 pF Trimmer	18-TM7013
C4	4-20 pF Trimmer	19-TM7013
C5	10 pF ± 0.5 pF, 750 V	16-TM7013
C6	16 μ F +100 -20%, 50 V	17-TM7013
C7	22 μ F +100 -20%, 25 V	16-TM7012
C8	220 μ F +100 -20%, 25 V	20-TM7012
C9	0.01 μ F $\pm 10\%$, 400 V	18-TM7012
C10	16 μ F +100 -20%, 50 V	21-TM7012
C11	50 μ F +100 -20%, 25 V	17-TM7012
C12	0.1 μ F $\pm 25\%$, 350 V	23-TM7012
C13	100 pF $\pm 2\%$, 750 V	39-TM6885
C14	47 pF $\pm 2\%$, 750 V	38-TM6885
C15	0.001 μ F $\pm 10\%$, 500 V	41-TM6885
C16	0.001 μ F $\pm 10\%$, 500 V	41-TM6885
C17	50 μ F +100 -20%, 50 V	30-TM6884
C18	15 pF $\pm 5\%$ 750 V	40-TM 6885
METER		
M1	100 μ A, 1000 Ω	11-TM6841

Circuit Ref.	Description	Works Ref.
SEMICONDUCTOR DIODES		
MR1	CG 92H	26-TM7012
MR2	OA 95	28323-287
MR3	CG 92H	26-TM7012
PLUG		
PLA	Belling-Lee L1465/FP	17-TM4726/179
PL101	2-pin	12-TM7155
RESISTORS		
R1	7.5 k Ω $\pm$ 7% TE, 3/8 W/55°C	2-TM7013
R2	27 k Ω $\pm$ 7% TE, 3/8 W/55°C	5-TM 7013
R3	24 k Ω $\pm$ 7% TE, 3/8 W/55°C	4-TM7013
R4	18 k Ω $\pm$ 7% TE, 3/8 W/55°C	3-TM7013
R5	33 k Ω $\pm$ 7% TE, 3/8 W/55°C	4-TM7012
R6	47 k Ω $\pm$ 7% TE, 3/8 W/55°C	5-TM7012
R7	10 k Ω $\pm$ 2%, 1/4 W/55°C	7-TM7012
R8	3.3 k Ω $\pm$ 7%, 3/8 W/55°C	2-TM7012
R9	1 k Ω $\pm$ 2%, 1/4 W/55°C	6-TM7012
R10	1 k Ω $\pm$ 2%, 1/4 W/55°C	6-TM7012
R11	99 k Ω $\pm$ 1%, 1/4 W/70°C	10-TM7012
R12	10 k Ω $\pm$ 7% TE, 3/8 W/55°C	3-TM7012
R13	2.2 k Ω $\pm$ 7% TE, 3/8 W/55°C	27-TM6885
R14	3.6 k Ω $\pm$ 7% TE, 3/8 W/55°C	28-TM6885
R15	15 k Ω $\pm$ 7% TE, 3/8 W/55°C	29-TM6885
R19	600 Ω $\pm$ 1%, 1 W/70°C	16-TM6884

TE = total excursion

Circuit Ref.	Description	Works Ref.
VARIABLE RESISTORS		
RV1	10 k Ω $\pm$ 20%, 1/4 W/55 $^{\circ}$ C	8-TM7013
RV2	10 k Ω $\pm$ 20%, 1/4 W/55 $^{\circ}$ C	8-TM7013
RV3	10 k Ω $\pm$ 20%, 1/4 W/55 $^{\circ}$ C	8-TM7013
RV4	10 k Ω $\pm$ 20%, 1/4 W/55 $^{\circ}$ C	8-TM7013
SWITCHES		
SA	OUT. IMPED	18-TM6884
SB	LOAD INT/EXT	19-TM6884
SC	IN. VOLTMETER	52-TM6885
SOCKETS		
SKTB	H. T. IN, 2-pin	47-TM6885
SKTC	ATTEN IN (Front), BNC 50 Ω	46-TM6885
TRANSFORMER		
T1		1-TM6884
TERMINALS		
TP1	BAL	10-TM6841
TP2	BAL/UNBAL	10-TM6841
TP3	E	10-TM6841
TP4	C. T.	10-TM6841
TRANSISTORS		
VT1	BCY71	29-TM7012
VT2	BCY71	29-TM7012

CIRCUIT NOTES

1. COMPONENT VALUES

Resistors : No suffix = ohms, k = kilohms, M = megohms.

Capacitors : No suffix = microfarads, p = picofarads.

* value selected during test; nominal value shown.

2. SYMBOLS

➔ arrow indicates clockwise rotation of knob

FUNCTION panel marking

3. ROTARY SWITCHES

Drawn as viewed from knob end with knob fully counter-clockwise.

1F = 1st section, front

1B = 1st section, back

2F = 2nd section, front

etc.

ADD dB



ATTN
IN
(REAR)

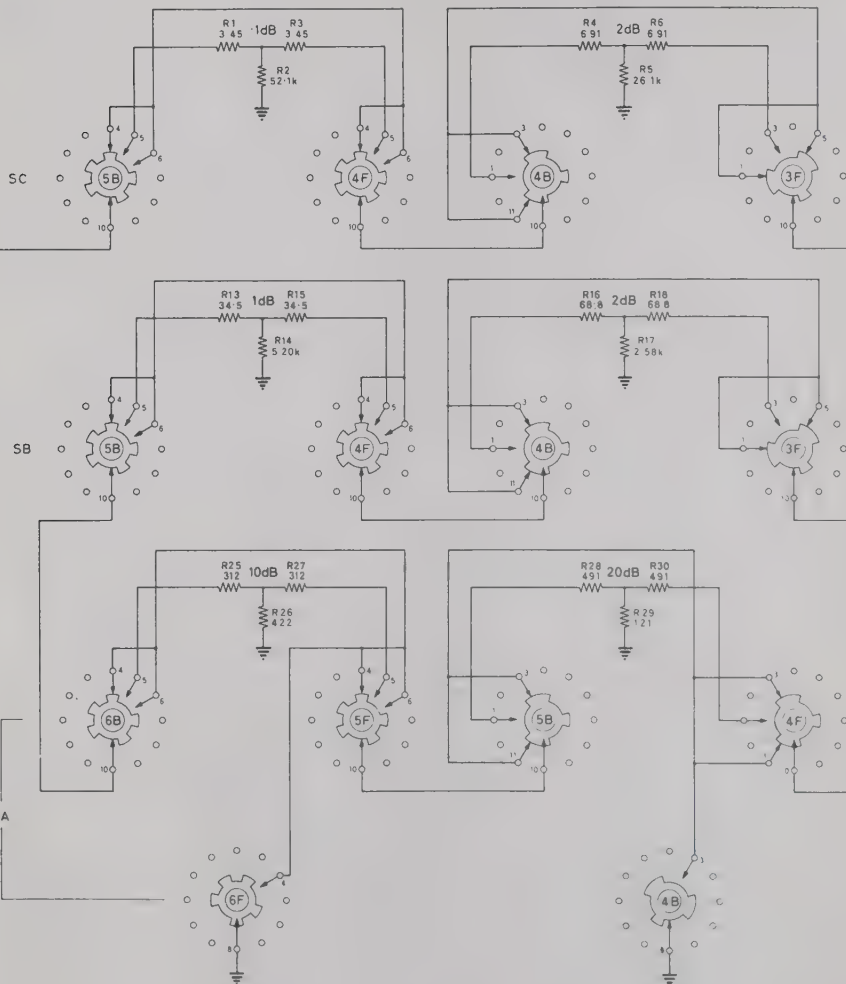
		PAD SECTION IN CIRCUIT			
		1	2	3	4
DECADE STEP - SA, SB OR SC	0	—	—	—	—
	1	T	—	—	—
	2	—	T	—	—
	3	T	T	—	—
	4	—	—	—	T
	5	T	—	—	T
	6	—	T	—	T
	7	—	—	T	T
	8	T	—	T	T
	9	—	T	T	T
	10	T	T	T	T
	∞	—	—	O	T



T - T SECTION
— - SHORTING LINK
O - OPEN CIRCUIT
∞ SETTING APPLIES TO
SB AND SC ONLY

PAD SECTION 1

2



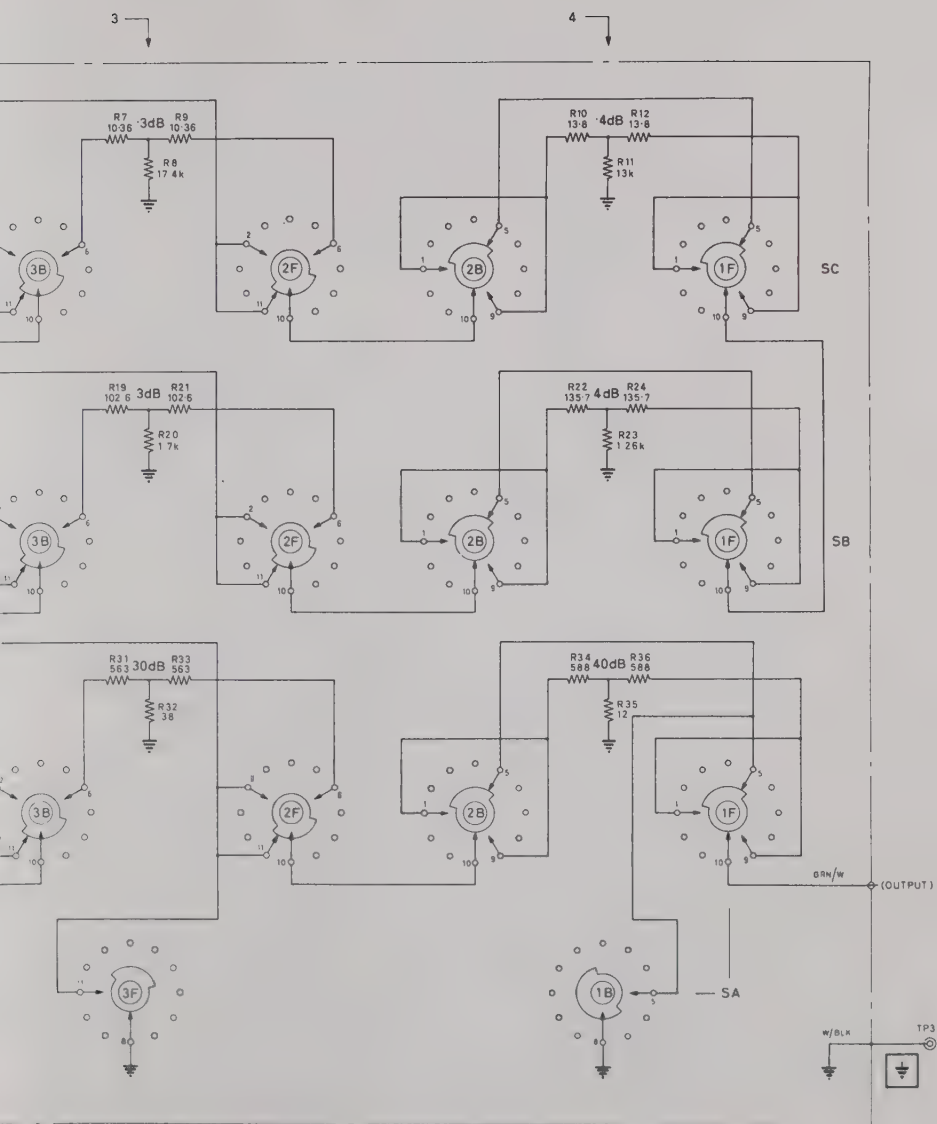


Fig 4-2 STEP ATTENUATOR

CIRCUIT NOTES

1. COMPONENT VALUES

Resistors : No suffix = ohms, k = kilohms, M = megohms.

Capacitors : No suffix = microfarads, p = picofarads.

* value selected during test; nominal value shown.

2. VOLTAGES

Shown in italics. These are d.c. and relative to the + supply line unless otherwise indicated. Measured with a 20 k Ω /V meter on its 10 V range.

3. SYMBOLS

-  preset component
-  arrow indicates clockwise rotation of knob
-  panel marking
-  printed board designation
-  printed board tag number

4. SWITCHES

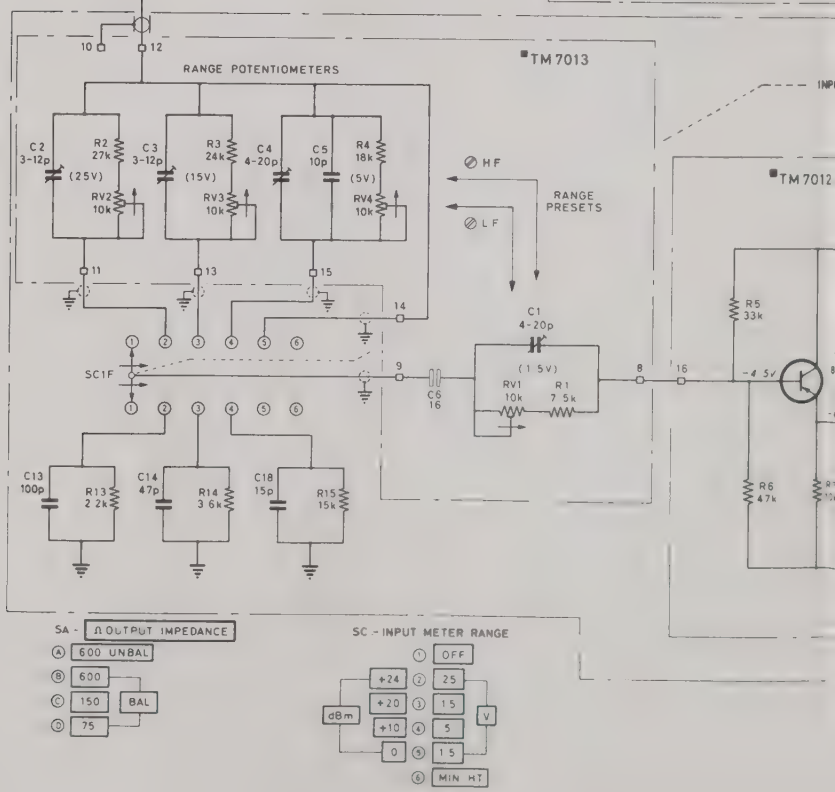
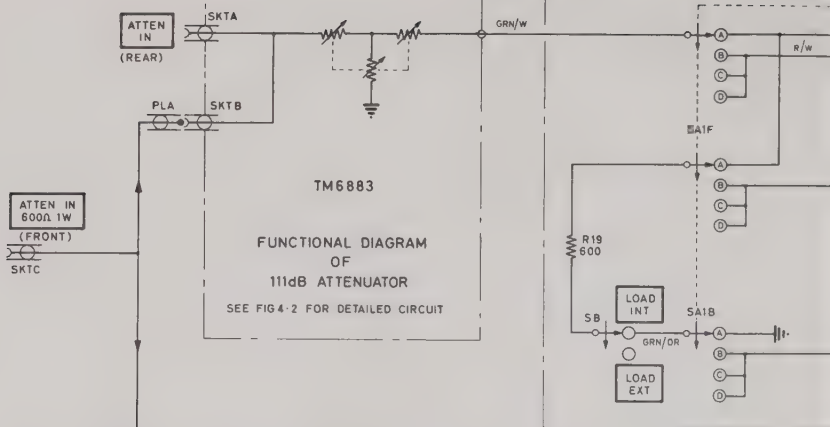
Rotary switches are drawn schematically. Numbers or letters indicated control knob setting as shown in key diagrams.

1F = 1st section, front

1B = 1st section, rear

2F = 2nd section, front

etc.



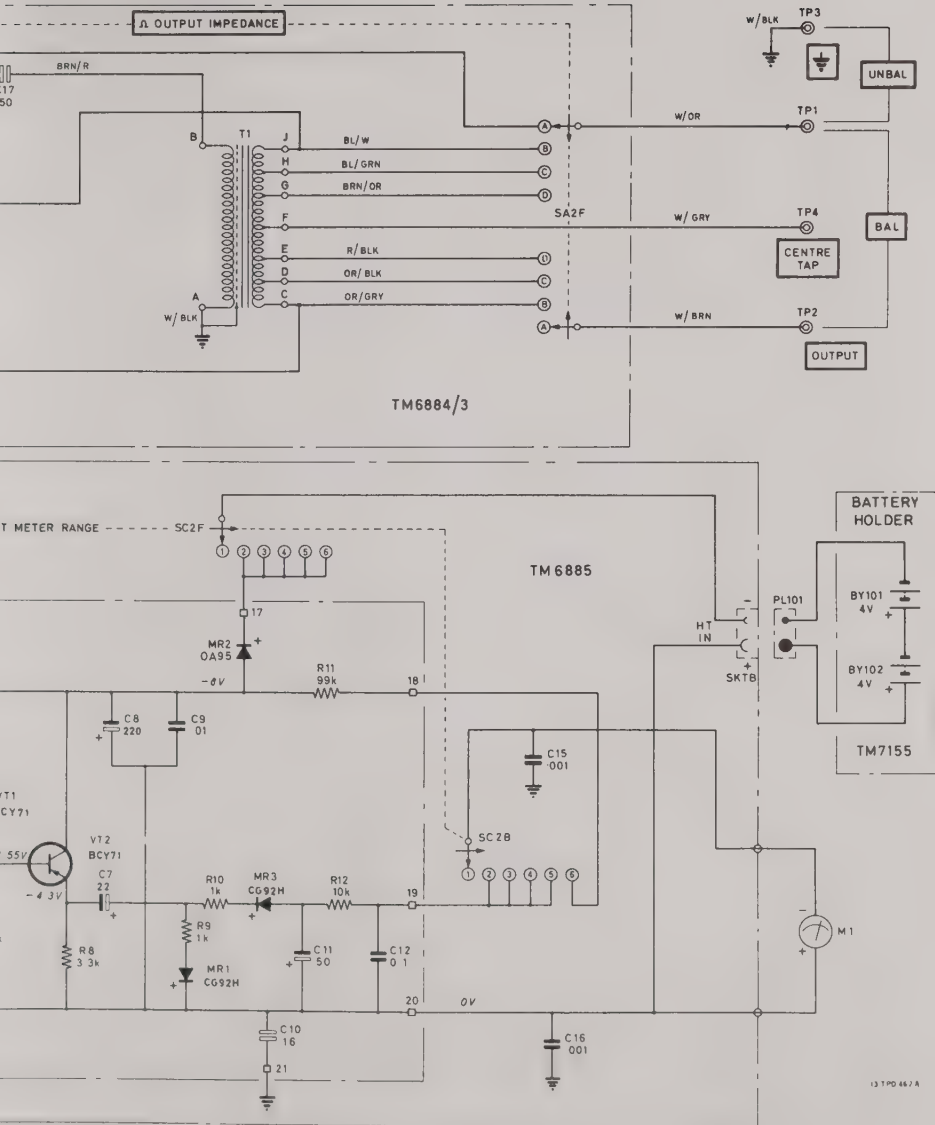


Fig.4-3 INPUT VOLTMETER and OUTPUT CIRCUIT

DECIBEL CONVERSION TABLE

Ratio Down			Ratio Up	
VOLTAGE	POWER	DECIBELS	VOLTAGE	POWER
1.0	1.0	0	1.0	1.0
.9886	.9772	.1	1.012	1.023
.9772	.9550	.2	1.023	1.047
.9661	.9333	.3	1.035	1.072
.9550	.9120	.4	1.047	1.096
.9441	.8913	.5	1.059	1.122
.9333	.8710	.6	1.072	1.148
.9226	.8511	.7	1.084	1.175
.9120	.8318	.8	1.096	1.202
.9016	.8128	.9	1.109	1.230
.8913	.7943	1.0	1.122	1.259
.8710	.7586	1.2	1.148	1.318
.8511	.7244	1.4	1.175	1.380
.8318	.6918	1.6	1.202	1.445
.8128	.6607	1.8	1.230	1.514
.7943	.6310	2.0	1.259	1.585
.7762	.6026	2.2	1.288	1.660
.7586	.5754	2.4	1.318	1.738
.7413	.5495	2.6	1.349	1.820
.7244	.5248	2.8	1.380	1.905
.7079	.5012	3.0	1.413	1.995
.6683	.4467	3.5	1.496	2.239
.6310	.3981	4.0	1.585	2.512
.5957	.3548	4.5	1.679	2.818
.5623	.3162	5.0	1.778	3.162
.5309	.2818	5.5	1.884	3.548
.5012	.2512	6	1.995	3.981
.4467	.1995	7	2.239	5.012
.3981	.1585	8	2.512	6.310
.3548	.1259	9	2.818	7.943
.3162	.1000	10	3.162	10.000
.2818	.07943	11	3.548	12.59
.2512	.06310	12	3.981	15.85
.2239	.05012	13	4.467	19.95
.1995	.03981	14	5.012	25.12
.1778	.03162	15	5.623	31.62

DECIBEL CONVERSION TABLE (continued)

Ratio Down			Ratio Up	
VOLTAGE	POWER	DECIBELS	VOLTAGE	POWER
·1585	·02512	16	6·310	39·81
·1413	·01995	17	7·079	50·12
·1259	·01585	18	7·943	63·10
·1122	·01259	19	8·913	79·43
·1000	·01000	20	10·000	100·00
·07943	$6·310 \times 10^{-3}$	22	12·59	158·5
·06310	$3·981 \times 10^{-3}$	24	15·85	251·2
·05012	$2·512 \times 10^{-3}$	26	19·95	398·1
·03981	$1·585 \times 10^{-3}$	28	25·12	631·0
·03162	$1·000 \times 10^{-3}$	30	31·62	1,000
·02512	$6·310 \times 10^{-4}$	32	39·81	$1·585 \times 10^3$
·01995	$3·981 \times 10^{-4}$	34	50·12	$2·512 \times 10^3$
·01585	$2·512 \times 10^{-4}$	36	63·10	$3·981 \times 10^3$
·01259	$1·585 \times 10^{-4}$	38	79·43	$6·310 \times 10^3$
·01000	$1·000 \times 10^{-4}$	40	100·00	$1·000 \times 10^4$
$7·943 \times 10^{-3}$	$6·310 \times 10^{-5}$	42	125·9	$1·585 \times 10^4$
$6·310 \times 10^{-3}$	$3·981 \times 10^{-5}$	44	158·5	$2·512 \times 10^4$
$5·012 \times 10^{-3}$	$2·512 \times 10^{-5}$	46	199·5	$3·981 \times 10^4$
$3·981 \times 10^{-3}$	$1·585 \times 10^{-5}$	48	251·2	$6·310 \times 10^4$
$3·162 \times 10^{-3}$	$1·000 \times 10^{-5}$	50	316·2	$1·000 \times 10^5$
$2·512 \times 10^{-3}$	$6·310 \times 10^{-6}$	52	398·1	$1·585 \times 10^5$
$1·995 \times 10^{-3}$	$3·981 \times 10^{-6}$	54	501·2	$2·512 \times 10^5$
$1·585 \times 10^{-3}$	$2·512 \times 10^{-6}$	56	631·0	$3·981 \times 10^5$
$1·259 \times 10^{-3}$	$1·585 \times 10^{-6}$	58	794·3	$6·310 \times 10^5$
$1·000 \times 10^{-3}$	$1·000 \times 10^{-6}$	60	1,000	$1·000 \times 10^6$
$5·623 \times 10^{-4}$	$3·162 \times 10^{-7}$	65	$1·778 \times 10^3$	$3·162 \times 10^6$
$3·162 \times 10^{-4}$	$1·000 \times 10^{-7}$	70	$3·162 \times 10^3$	$1·000 \times 10^7$
$1·778 \times 10^{-4}$	$3·162 \times 10^{-8}$	75	$5·623 \times 10^3$	$3·162 \times 10^7$
$1·000 \times 10^{-4}$	$1·000 \times 10^{-8}$	80	$1·000 \times 10^4$	$1·000 \times 10^8$
$5·623 \times 10^{-5}$	$3·162 \times 10^{-9}$	85	$1·778 \times 10^4$	$3·162 \times 10^8$
$3·162 \times 10^{-5}$	$1·000 \times 10^{-9}$	90	$3·162 \times 10^4$	$1·000 \times 10^9$
$1·000 \times 10^{-5}$	$1·000 \times 10^{-10}$	100	$1·000 \times 10^5$	$1·000 \times 10^{10}$
$3·162 \times 10^{-6}$	$1·000 \times 10^{-11}$	110	$3·162 \times 10^5$	$1·000 \times 10^{11}$
$1·000 \times 10^{-6}$	$1·000 \times 10^{-12}$	120	$1·000 \times 10^6$	$1·000 \times 10^{12}$
$3·162 \times 10^{-7}$	$1·000 \times 10^{-13}$	130	$3·162 \times 10^6$	$1·000 \times 10^{13}$
$1·000 \times 10^{-7}$	$1·000 \times 10^{-14}$	140	$1·000 \times 10^7$	$1·000 \times 10^{14}$

MANUAL CHANGE
for
AF SIGNAL SOURCE TF 2000

One or more of the parts fitted to the instrument may differ from those in the component lists or circuit diagrams for any of the following reasons :

- (a) Components indicated by * have their value selected during test to achieve particular performance limits.
- (b) Owing to supply difficulties components may be substituted by others of different type or value provided that the overall performance of the instrument is maintained.
- (c) As part of a policy of continuous development, components may be changed in value or type to obtain detail improvements in performance.

Whenever there is such a difference between the component fitted and the one listed, always use a replacement of the same type and value as found in the instrument.

MARCONI INSTRUMENTS LIMITED

SERVICE DIVISION

THE AIRPORT, LUTON,
BEDFORDSHIRE LU2 9NS

Telephone: (0582) 33866
Telex: 825248

HOME and EXPORT
SALES OFFICES

LONGACRES, ST. ALBANS,
HERTFORDSHIRE AL4 0JN

Telephone: (0727) 59292
Telegrams: Measuretest, St. Albans
Telex: 23350

U.S.A.

MARCONI INSTRUMENTS DIVISION,
MARCONI ELECTRONICS INC.,
100 STONEHURST COURT, NORTHVALE,
NEW JERSEY 07647

Telephone: (201) 767-7250
Telex: 710-991-9752

BUNDESREPUBLIK
DEUTSCHLAND

MARCONI MESSTECHNIK G.m.b.H.,
P.O. BOX NO. 210330
JOERGSTRASSE 74
8 MUNICH 21

Telephone: 582041
Telex: 05 24642

FRANCE

MARCONI INSTRUMENTS,
SUCCURSALE DE FRANCE,
32 AVENUE DES ECOLES,
91600 SAVIGNY SUR ORGE

Telephone: 921.93.86
Telex: 60541

A GEC-MARCONI ELECTRONICS COMPANY

www.manualsplus.com



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